

# 15

## **Income and Interest Rates under Floating Exchange Rates, and the International Trilemma**

### Overview

In this chapter, we learn:

- how floating exchange rates adjust to restore external equilibrium
- how, with floating rates, fiscal and monetary policy affect output and exchange and interest rates
- how floating rates make fiscal policy less effective but monetary policy more effective
- how the effectiveness of fiscal and monetary policies depends on the exchange rate regime when there is perfect mobility of capital
- how a liquidity trap will prevent expansionary monetary policy from increasing output
- why an economy cannot simultaneously achieve stability, monetary independence and financial integration

## 15.1 Introduction

*"It's a bleak picture," said...a policy analyst.... "Many of these towns aren't going to make it. They're going to have to go through bankruptcy and let the chips fall where they may."*

*The municipalities' financial problems grow out of the severe depression that in recent years has savaged the country's steel industry, idling more than 700,000 workers in this once prosperous region....*

*Hammered by the strength of the dollar, which made imported steel less expensive, and bypassed by the economic recovery, steel companies have closed one mill after another. Once the backbone of the region's economy, the mills are now silent, soot-stained monuments to another era.*

From, Lindsay Gruson, *New York Times*, October 6, 1985

This news article from the 1980s is perplexing. By 1985, the economic recovery was well under way. And yet in the industrial heartland, shuttered factories and laid-off workers meant that some city governments didn't even have enough tax revenue to pay their employees. How can a strong dollar be blamed for this outcome? The fact is, the robust dollar was a key reason for the rapid decline of the industrial Midwest, and surging imports were part of the story. How and why these events played out motivates the development of the model in this chapter.

In contrast to the model presented in Chapter 14, the central bank in this new model is no longer committed to exchanging home currency for foreign currency at a designated exchange rate. Rather, the central bank eschews foreign exchange intervention, and thus gains monetary policy autonomy. Foreign exchange reserves no longer change in response to changes in interest rates and trade flows. Instead, the exchange rate freely adjusts in response to market forces, so as to keep foreign exchange reserves constant. Because of this switch in which variable is free to move and which is not, the model's predictions differ substantially from those obtained in Chapter 14.

Relief for those struggling Midwestern towns began to come when the Federal Reserve, satisfied with the defeat of inflation, relented in late 1984. With some delay, declining interest rates resulted in a weakening dollar from March 1985 through early 1988. But much damage had already been done. Manufacturing employment declined 1.8% in 1985, despite a booming overall economy that added 2.4% to total employment. By 1988 worst was over. Eventually, manufacturing employment recovered. However, it never recovered in the places where it had been drastically reduced, namely in the states surrounding the Great Lakes. By and large, manufacturing-based communities retooled, like Pittsburgh and Cleveland, or stagnated, like Gary and Erie. So even if the impact on the aggregate economy was temporary, certain geographic effects were permanent.

## 15.2 Fiscal and Monetary Policy under Floating Exchange Rates

We retain the IS, LM and BP=0 schedules as described in the previous chapter, but with one critical difference: the real exchange rate  $q$  is now an endogenous variable instead of an exogenous one. That is, the rate is now allowed to float instead of being fixed by policy.

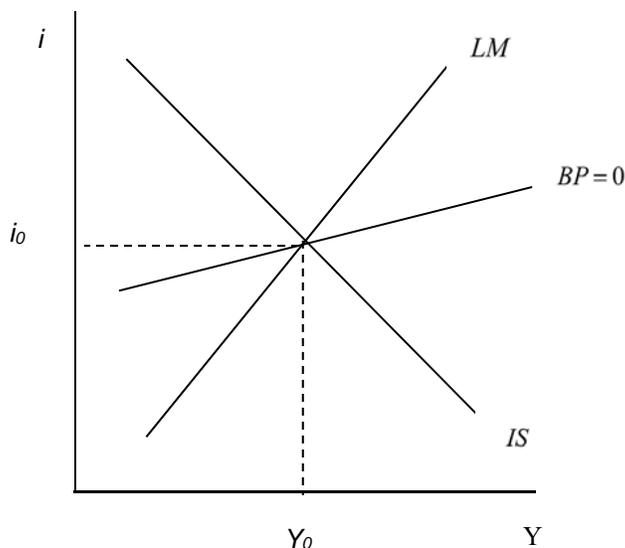
Here are the three key equations from the last chapter, with  $q$ 's new status marked by the removal of the overbar:

$$(15.1) \quad Y = \bar{\alpha}[\bar{A} + \bar{X} - \bar{IM} + (n + v)q - bi] \quad \text{<IS curve>}$$

$$(15.2) \quad i = -\left(\frac{1}{h}\right)\left(\frac{\bar{M}}{\bar{P}}\right) + \left(\frac{k}{h}\right)Y \quad \text{<LM curve>}$$

$$(15.3) \quad i = -\left(\frac{1}{\kappa}\right)[(\bar{X} - \bar{IM} + \bar{FA}) + (n + v)q] + \bar{i}^* + \left(\frac{m}{\kappa}\right)Y \quad \text{<BP=0 curve>}$$

In the fixed exchange rate case,  $q$  is treated as a constant; it changes only when the central bank decides to devalue or revalue the currency. With a floating exchange rate,  $q$  is free to move in response to other forces. When the equilibrium interest rate is above (or below) that consistent with external equilibrium, the currency appreciates (or depreciates) so as to maintain the BP=0 condition. When the economy is at external equilibrium, as shown in Figure 15.1, there is no tendency for  $q$  to change.



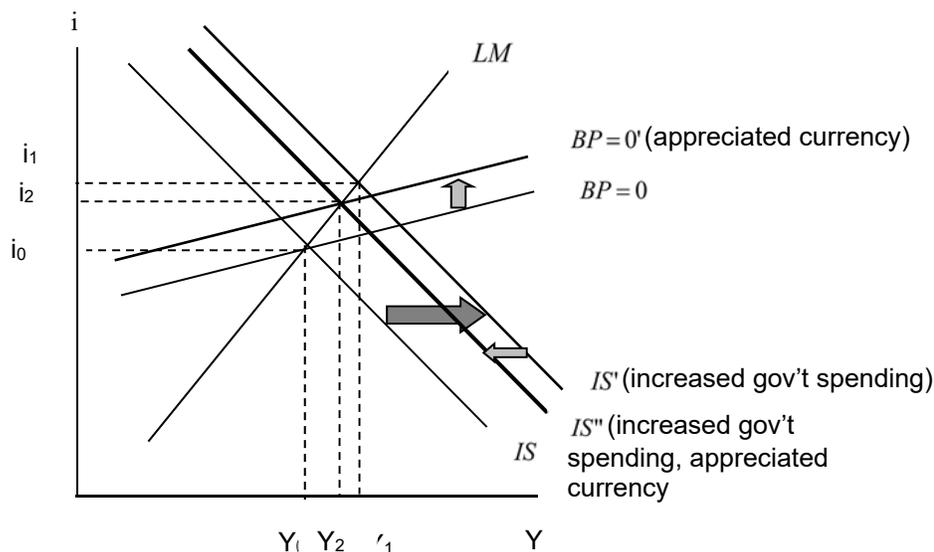
**Figure 15.1:** IS-LM-BP=0 in equilibrium

Figure 15.1 looks identical to Figure 14.1. The differences become apparent when we examine the implications, first, of fiscal policy and then of monetary policy.

### *Fiscal Policy*

Consider what happens when the government increases its spending. With increased  $\bar{A}$ , the IS

curve shifts out, as in Figure 15.2 (dark gray arrow). Output initially rises to  $Y_1$ , and interest rates to  $i_1$ . However, now the equilibrium interest rate is greater than that consistent with external equilibrium; it attracts inflows of foreign financial capital beyond those necessary to offset the trade balance. In the fixed exchange rate system, this would mean increases in official reserves. However, under the floating exchange rate system, the home currency appreciates, i.e.,  $q$  falls.



**Figure 15.2:** Expansionary fiscal policy under floating exchange rates, high capital mobility

As  $q$  falls, this affects two curves: by Equation (15.1), a fall in  $q$  shifts in the IS curve, and by Equation (15.3), a fall in  $q$  shifts up the  $BP=0$  curve. The two shifts are depicted in Figure 15.2 (light gray arrows). Equilibrium income falls back to  $Y_2$  and interest rates retreat to  $i_2$ , although both of these values are still higher than the initial values,  $Y_0$  and  $i_0$ .

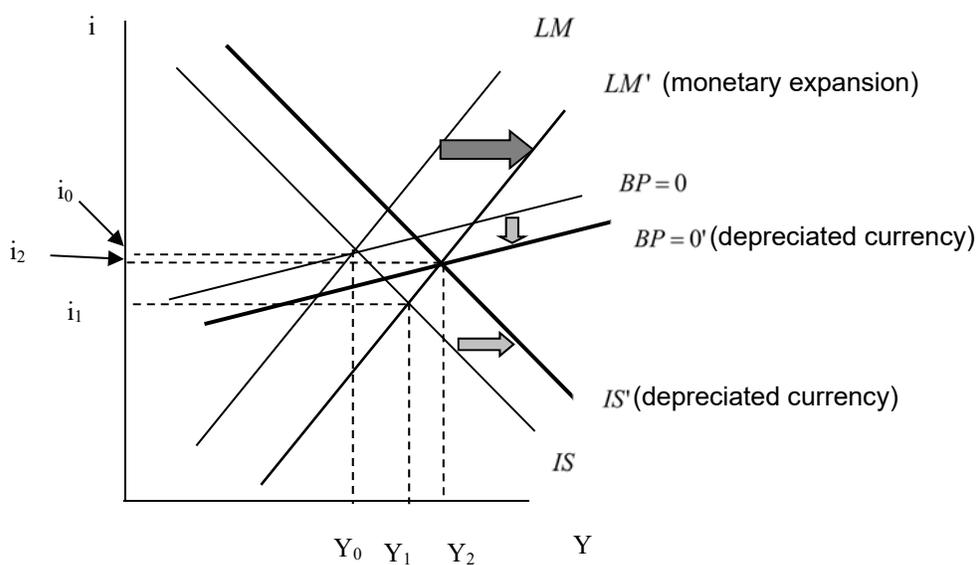
Why do the IS and  $BP=0$  shifts occur? As  $q$  falls (appreciates), exports ( $X = \bar{X} + vq$ ) fall and imports ( $IM = \bar{IM} + mY - nq$ ) increase. That means a decline in aggregate demand and an inward shift of the IS schedule. Meanwhile, as exports decrease and imports increase, with an appreciated currency, financial inflows must be higher for any given income level in order for external balance to hold. The only thing that attracts financial inflows is a higher interest rate, or, in other words, an upward-shifted  $BP=0$  curve.

In the end, in an open economy, some of the fiscal expansion is offset by reduced net exports. Another way to think about this phenomenon is that there is now an additional channel for crowding out—two components of aggregate demand that are sensitive to interest rates: investment spending and net exports. Net exports are not explicitly interest sensitive, but they do depend upon the exchange rate. To the extent the exchange rate in turn depends upon interest rates, net exports are in effect interest sensitive, after all.

### Monetary Policy

Now we consider what happens with a monetary expansion. Here we examine only the high capital mobility case, where (recall from Chapter 14) the slope  $m/\kappa$  of the  $BP = 0$  curve is shallow. The qualitative results are the same for a steeper  $BP = 0$  curve.

In Figure 15.3, the monetary expansion shifts out the LM curve (dark gray arrow). The resulting equilibrium interest rate  $i_1$  is less than that required for external equilibrium. As a consequence, financial inflows decline, there is an incipient balance of payments deficit, and the exchange rate depreciates. The depreciated exchange rate results in increased net exports, so the interest rate required for external equilibrium falls (the  $BP=0$  curve shifts downward). The increase in net exports also means an increase in domestic aggregate demand, so the IS curve shifts out. The economy settles into equilibrium at income level  $Y_2$  and interest rate  $i_2$ .



**Figure 15.3:** Expansionary monetary policy under floating exchange rates, high capital mobility

Notice that monetary policy is relatively powerful. The increase in the money supply decreases the interest rate and hence spurs capital investment, thereby increasing output. The lower interest rates also puts negative pressure on the balance of payments, and under a free float, this manifests itself in a depreciation of the home currency. This shifts down the  $BP=0$  curve (light gray arrow). The depreciation spurs exports and discourages imports, so the expansionary monetary policy “crowds in” net exports, as well as investment.

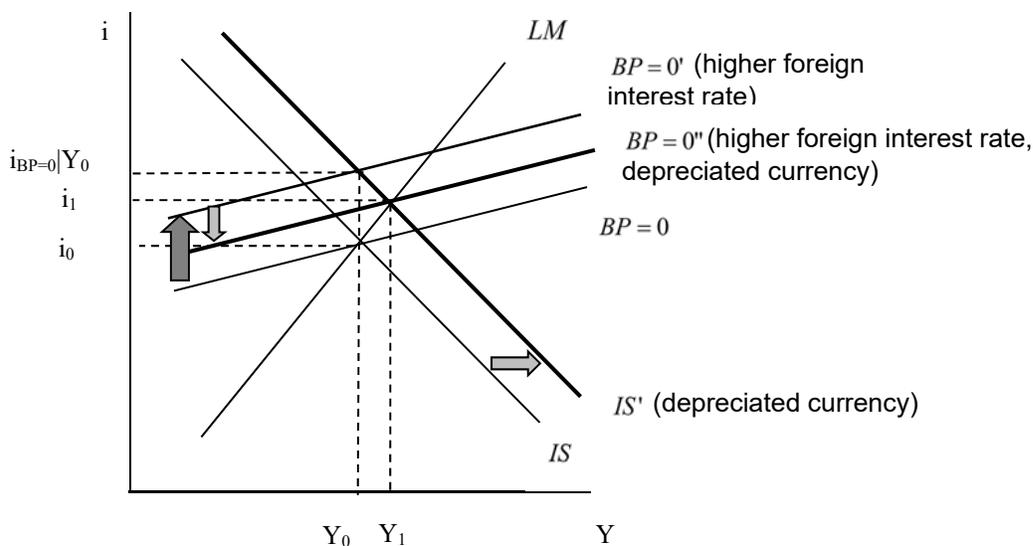
This result highlights the fact that in an open economy under a floating exchange rate regime, monetary policy is generally more powerful than in the case of a closed economy. That is because monetary policy can now exert its influence through two channels – the investment channel and the net exports channel. The greater the degree of financial capital mobility, the more this is true.

In a fully floating exchange rate regime, market conditions determine the currency's value. However, as we just saw, this does not mean that the central bank (and the government) cannot influence that value. In particular, the central bank can, by affecting the interest rate, affect the market conditions that underlie the exchange rate's level.

### Interest Rate Shocks

We have been examining the effects of domestic policies. However, the model is also quite useful for examining how events in the rest of the world can affect exchange rates and income at home. In mid-2014, for instance, expectations of a U.S. interest rate rise relative to the euro area rate led to a depreciation of the euro against the U.S. dollar.

If we model this event from the euro area perspective, the increase in the U.S. interest rate is a rise in  $\bar{i}^*$  in Equation (15.3). There, a rise in  $\bar{i}^*$  contributes one-for-one to a rise in the interest rate,  $i$ , that equilibrates the balance of payments. Thus, if the foreign (U.S.) interest rate rises (exogenously) by one percentage point, the  $BP=0$  curve will shift up one percentage point. The outcome in the high capital mobility case is depicted in Figure 15.4.



**Figure 15.4:** The interest rate in the rest of the world rises under floating exchange rates

As the foreign interest rate rises (dark arrow), the euro area interest rate is now below the interest rate consistent with external balance at income  $Y_0$ , namely  $i_{BP=0|Y_0}$ . The euro thus depreciates to  $q$ , shifting down the  $BP=0$  curve and shifting out the  $IS$  curve (light arrows). In the end, the euro area interest rate rises to  $i_1$  in response to the foreign interest rate increase, although not one-for-one.

To stabilize the exchange rate, the monetary authority (in this case the European Central Bank) could raise euro area interest rates. In Figure 15.4, this would entail a shift backwards of the  $LM$  curve. In other words, the authority could maintain the exchange rate at a given level, at the cost of losing control over output. In this case, the economy would undergo a recession. Since the euro area was already experiencing slow growth in 2014, the ECB did not tighten monetary

policy. This episode illustrates the tradeoffs that policymakers make. While it might be desirable to stabilize the currency's value, that benefit has to be weighed against the benefits of maintaining the current level of output.

### **15.3 Summarizing Effects under Fixed and Floating Exchange Rates**

Over the last chapter and this one, our examination of the effects of different policies has generated a large number of outcomes, depending on exchange rate regime, degree of capital mobility, and whether the central bank sterilizes financial capital flows. Table 15.1 summarizes these results, assuming relatively high capital mobility.

	Exchange rate regime	Income	Interest rate	Real exchange rate	Trade balance	Foreign Exchange Reserves
Government spending	Fixed (w/sterilization)	Increase	Increase	No change	Decrease	Increase
	Fixed	<b>Increase</b>	Increase	No change	Decrease	Increase
	Floating	Increase	Increase	Appreciation	Decrease	No change
Real money supply	Fixed (w/sterilization)	Increase	Decrease	No change	Decrease	Decrease
	Fixed	No change	No change	No change	No change	Decrease
	Floating	<b>Increase</b>	Decrease	Depreciation	Increase	No change
Real exchange rate <sup>1</sup>	Fixed (w/sterilization)	Increase	Increase	Devaluation	Increase	Increase
	Fixed	Increase	Increase	Devaluation	Increase	Increase
Foreign interest rate	Fixed (w/sterilization)	No change	No change	No change	No change	Decrease
	Fixed	Decrease	Increase	No change	Increase	Decrease
	Floating	Increase	Increase	Depreciation	Depreciation	No change

**Table 15.1: The Impact of Policies and Foreign Developments.** Responses of each variable in the column to a change in the indicated variable in left column, under fixed exchange rate regime with sterilization, without sterilization, and free floating. Entries in bold italics indicate relatively large changes.

### *Empirical Estimates of Policy Effects*

Theory provides insights into the effectiveness of fiscal, monetary and exchange rate policies in open economies. Under fixed exchange rates, fiscal policy should be relatively effective but monetary policy relatively ineffective (particularly in the longer term). The reverse is true under floating exchange rates: fiscal policy should be less effective, but monetary policy more effective, holding all else constant.

How well do these predictions hold up in the real world? Ethan Ilzetzki, Enrique Mendoza and Carlos Végh (2013) used data on a number of national economies to infer

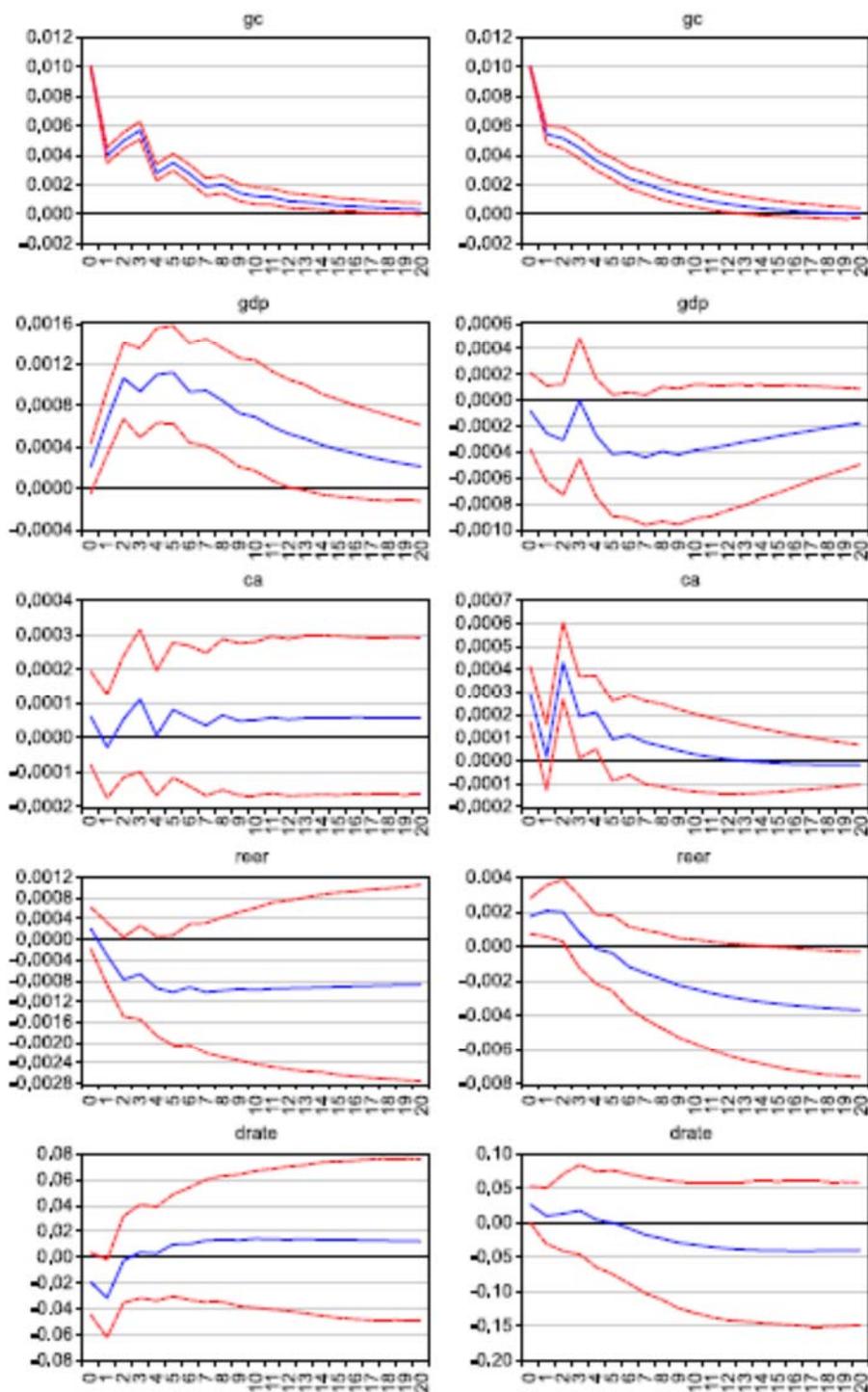
<sup>1</sup> There is no entry for floating under real exchange rate, because under a floating regime, the exchange rate is an endogenous variable, rather than one set by policy.

how output, the current account, and the real exchange rate would respond to a hypothetical sudden increase (shock) in government spending, equal to one percent of GDP. They also considered the response of the central bank's policy interest rate.<sup>2</sup>

Figure 15.5 shows the response of each variable over twenty quarters, with fixed exchange rate regimes on the left and floating rate regimes on the right. The blue lines indicate the estimated effects, while the red lines mark the 90% confidence intervals for these estimates. A response is statistically significant when both red lines lie on the same side of the zero line.

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<sup>2</sup> In contrast to the Mundell-Fleming model we've been using, the study assumed that the central bank can react to fiscal policy. Hence, the study scenarios do not exactly correspond to our examples, where monetary policy is held fixed (either by sterilization in fixed rates, or under floating rates).



**Figure 15.5:** Impulse responses to a 1% shock to government consumption in episodes of fixed exchange rates (left panels) and flexible exchange rates (right panels). Impulse response from top to bottom: government consumption (i.e., spending on goods and services); gross domestic product; current account as a percentage of GDP; the real effective exchange rate (defined so that a rise is a currency appreciation); policy interest rate of the central bank. The time dimension is quarterly. Dotted lines represent 90% confidence intervals based on Monte Carlo simulations.

*Fixed exchange rate regimes.* With fixed exchange rates, GDP increases, with peak effect coming about a year after the government spending shock. Over time, the impact tails off toward zero (which matches up with theory that will be outlined in Chapter 16). Within three years of the government spending increase, the impact on GDP is not statistically significant.

The current account and the real exchange rate responses deviate from zero only by a statistically insignificant amount. The policy rate is the rate set by the central bank, rather than the market rate discussed in the model. In the estimates, the policy rate deviates by an economically and statistically insignificant amount. To the extent it moves, it falls (i.e., monetary policy is accommodative).

*Floating exchange rate regimes.* With floating rates, GDP does not respond in a statistically significant manner. The fact that the response under floating is less than under fixed is consistent with the Mundell-Fleming model. The real exchange rate initially appreciates, and then reverts back to zero within a year. The policy rate rises slightly in response to the fiscal policy.

The current account, which approximately equals the trade balance, responds somewhat counter-intuitively. Instead of declining, as it should under flexible rates, it rises (erratically) in the 0<sup>th</sup> and 2<sup>nd</sup> quarter after the government spending occurs. Why this result is obtained is a hard question to answer, partly because the predictions are clear if everything else is held constant. In reality, the degree of openness to international trade, the degree of capital mobility, and the degree of capital openness all vary.<sup>3</sup>

The data from the real world confirms the key conclusion that fiscal policy is less effective under flexible rates than under fixed.

#### 15.4 Application: The Dollar and Deficits during the 1980s

At the start of the chapter, we recalled the problems of the industrial heartland of America during the mid-1980s – declining manufacturing and high unemployment. This experience can readily be explained using the model we’ve just described.

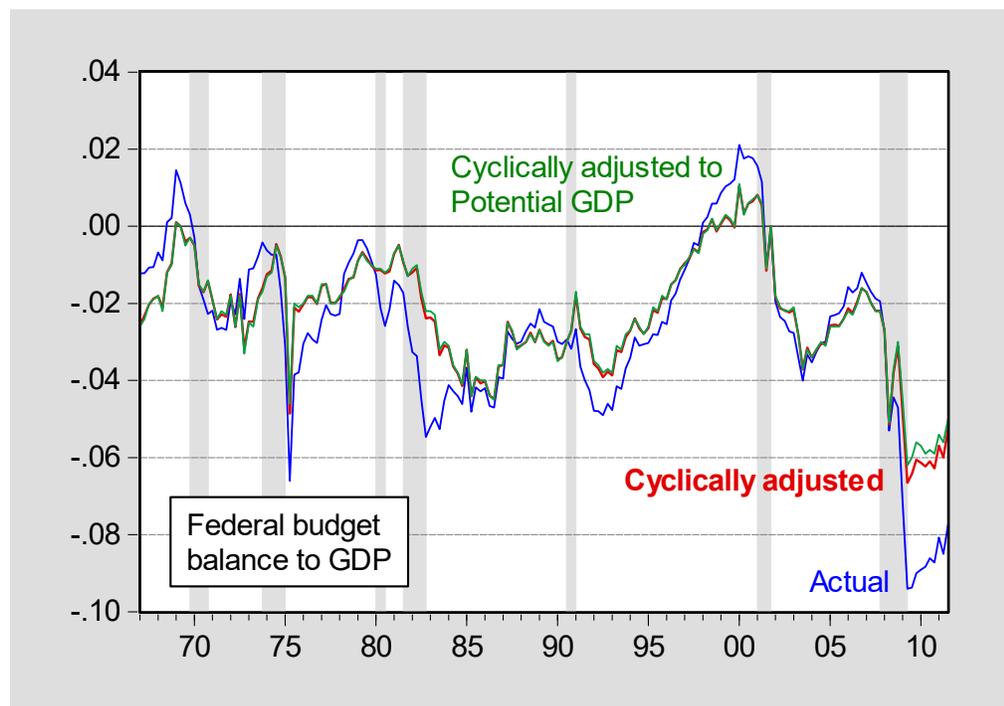
When President Ronald Reagan took office in January 1981, he initiated tax cuts and defense spending increases that, along with a recession that soon began, caused a large budget deficit.<sup>4</sup> We have defined the budget balance as tax,  $T$ , minus government spending,  $G$ , but this is not an exogenous measure of the stance of fiscal policy, since tax receipts fall during recessions, while spending on transfers such as unemployment insurance rise. A more exogenous measure of the budgetary impact of fiscal policy is the budget balance evaluated at full employment, sometimes called the **cyclically adjusted budget balance**, typically expressed as a share of GDP or full-

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<sup>3</sup> This anomalous result might arise because developing countries, which account for a large number of floating exchange rate regimes, exhibit this behavior. For those countries, a government spending increase results in an increase in the current account, something that is not predicted by any particular theory.

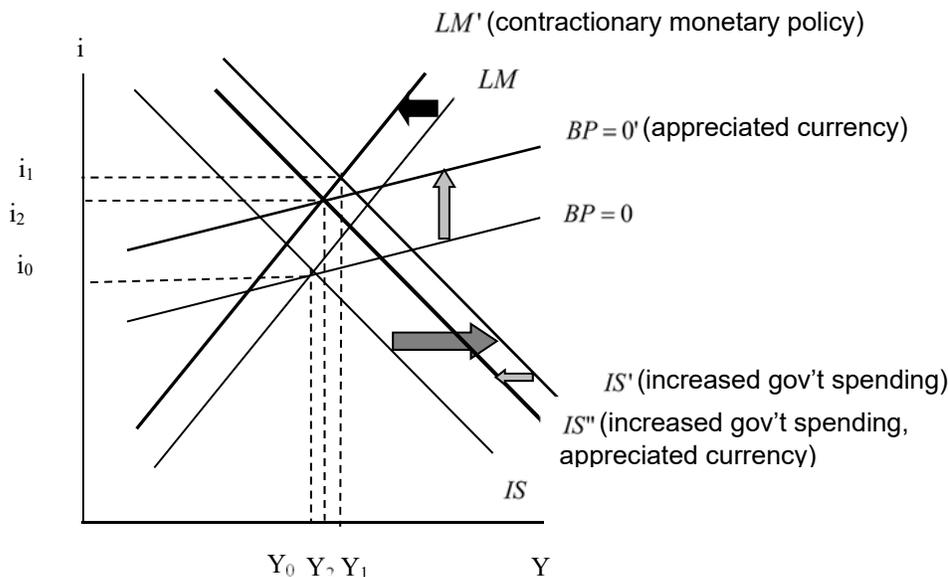
<sup>4</sup> In retrospect, by official criteria, the U.S. economy was in the “pause” portion of a double-dip recession, having just emerged from a six months of recession and about to enter another year and a half of it.

employment GDP. This measure, along with the cyclically adjusted, normalized by GDP and full employment GDP ( $Y^{FE}$ ), is shown in Figure 15.6.



**Figure 15.6:** Actual budget balance to GDP ratio (blue), cyclically adjusted budget balance ratio to GDP (red) and cyclically adjusted budget balance to full employment GDP ratio (green). Source: Congressional Budget Office, *Budget and Economic Outlook*, August 2011.

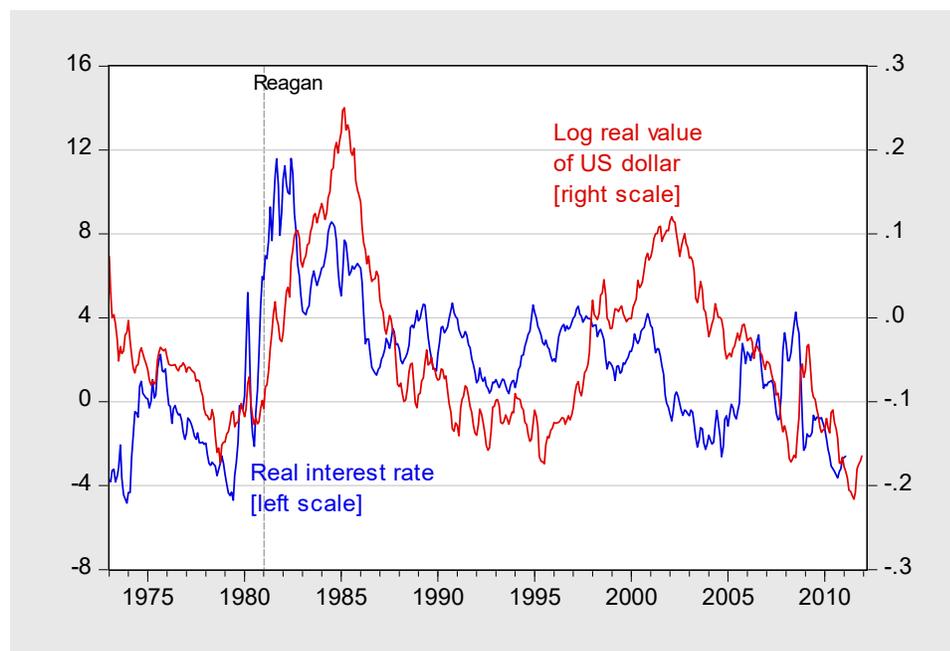
Under Reagan, lower taxes and higher spending combined to increase the cyclically adjusted budget deficit by about 3 percentage points of GDP. The stimulating effect on the economy appears in Figure 15.7 as an outward shift in the IS curve (dark gray arrow). At the same time, the Federal Reserve, under the leadership of Chairman Paul Volcker, embarked on a policy of squeezing inflation out of the economy through contractionary monetary policy. This appears as an inward shift of the LM curve (black arrow), so that the interest rate rises to  $i_1$ . Assuming high capital mobility, this combination of fiscal and monetary policy leads to a large appreciation of the currency, which leads to shifts of the BP=0 and IS curves (light gray arrows).



**Figure 15.7:** Expansionary fiscal policy and contractionary monetary policy under flexible exchange rates, high capital mobility

The economy settles at income level  $Y_2$  and interest rate  $i_2$ . The final income level exceeds the starting level,  $Y_0$ , but not by as much as would have been the case if monetary policy had been less contractionary. This collision of expansionary fiscal policy and contractionary monetary policy is like stepping on the gas and brake pedals at the same time.

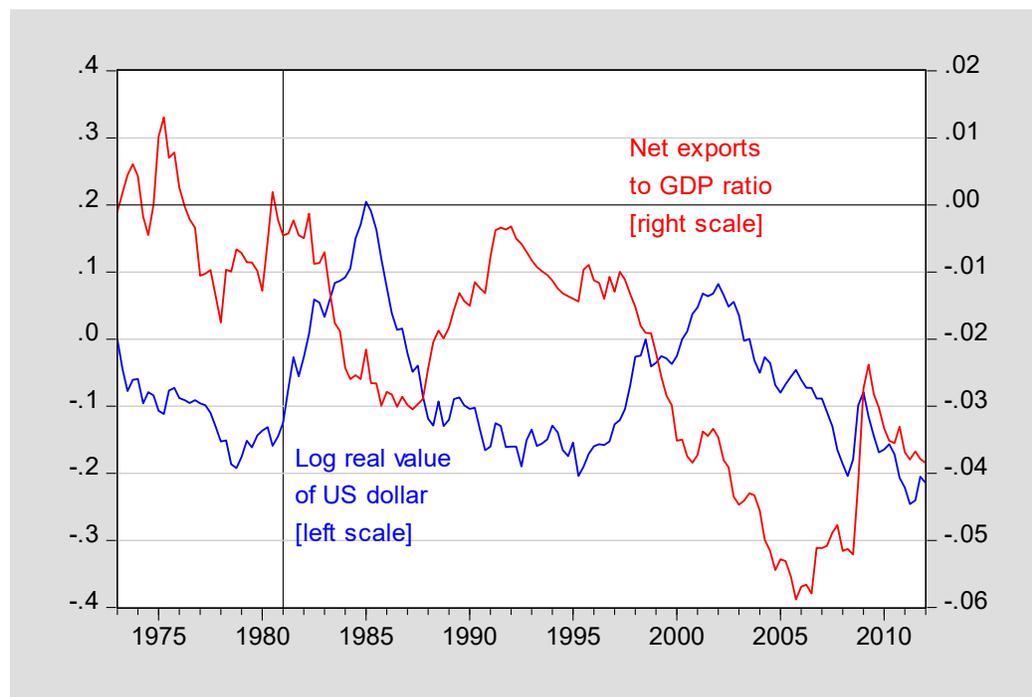
The model also implies that the interest rate increase from  $i_0$  to  $i_2$  should appreciate the dollar. That is exactly what happened, as Figure 15.8 illustrates.



**Figure 15.8:** Real interest rate (left scale) and log real value of U.S. dollar (1973M01=0). Real interest rate calculated as difference between one-year Treasury yield and one-year ex post inflation. Source:

Federal Reserve Board, and BLS.

From Reagan's inauguration to the dollar's peak in March 1985, the real value of the currency rose by 35%. During that same time frame, as shown in Figure 15.9, the U.S. began running a massive trade deficit, unprecedented in the post-World War II era. The appreciated dollar was largely to blame. Instead of fiscal policy crowding out investment, as would have occurred in the closed economy model, the fiscal policy crowded out net exports.



**Figure 15.9:** Log real value of U.S. dollar (1973M1=0), and net exports as a share of GDP. Source: Federal Reserve Board, and BEA.

The simultaneous onset of deterioration in the budget and trade balances came to be called the Twin Deficits, as described in Chapter 11. The appreciation of the dollar made U.S. exports relatively uncompetitive in markets overseas, while it made imported goods cheaper for American consumers and firms. Manufacturers were hit hard by the combination of recession and increased import competition. The industrial cities of the Great Lakes region, from New York to Illinois, suffered deeply, earning that stretch of geography an unwelcome new nickname: the Rust Belt.

Starting toward the end of 1984, Fed policy loosened considerably. That plus tax increases caused the U.S. interest differential relative to other countries to decline, and so, too, did the dollar. With a lag of a couple years (as shown in Figure 15.9), U.S. net exports responded to the dollar decline, so that by 1987, the trade deficit shrank as a share of GDP.

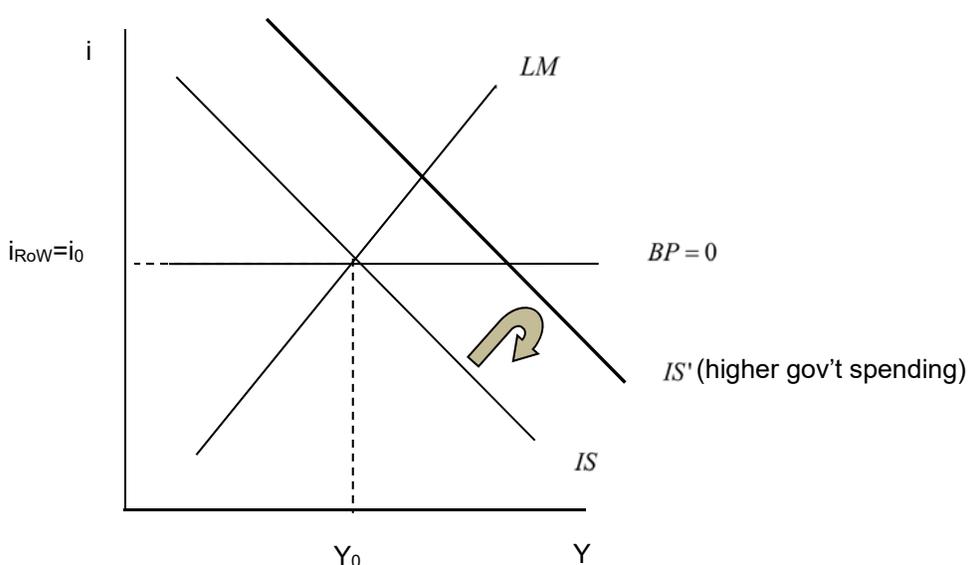
### 15.5 The Implications of Perfect Capital Mobility

Our examples have typically assumed that financial flows are highly sensitive to differentials in

returns. In our model, this has meant assuming that  $\kappa$  is large enough so that  $m/\kappa$ , the slope of the  $BP = 0$  curve, is less than  $k/h$ , the slope of the LM curve. The assumption makes sense particularly for advanced economies, such as the euro area or Japan, which have largely removed legal and regulatory barriers to the cross-border movement of funds. These economies represent an important special case, where **perfect capital mobility** holds. Under those circumstances, extreme results occur when either monetary or fiscal policies are implemented.

### *Floating exchange rates*

Consider, first, floating rate regimes. In the context of the model, perfect capital mobility is defined as the situation where capital is *infinitely* sensitive to interest differentials. Then  $m/\kappa = 0$ , and the  $BP=0$  curve is a horizontal line, as in Figure 15.10.

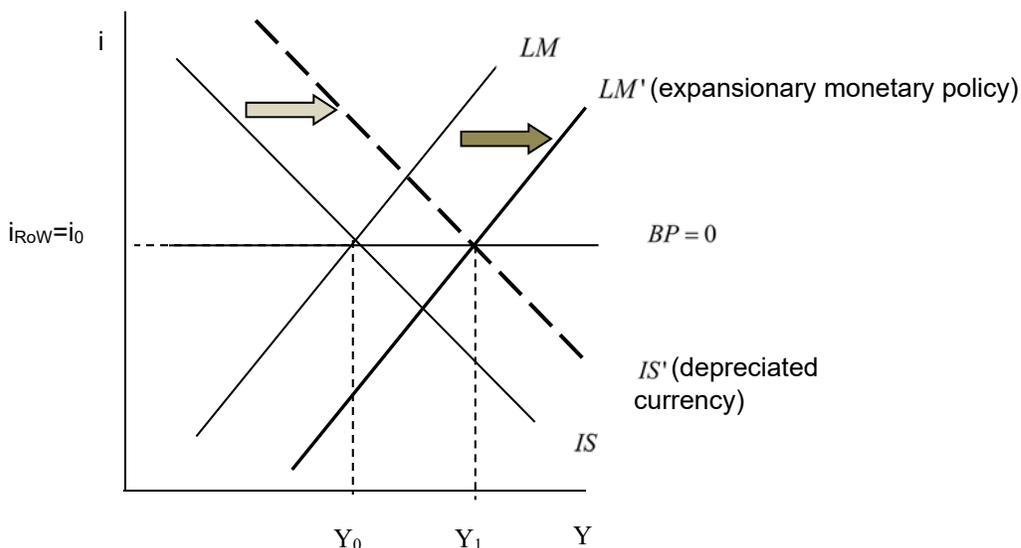


**Figure 15.10:** Perfect capital mobility, with expansionary fiscal policy under floating rates

If expansionary fiscal policy is implemented, then the IS curve shifts out. The interest rate rises above the foreign interest rate, inducing an infinitely large financial inflow that appreciates the home currency, pulling the IS curve back in. As long as the interest rate is above the foreign, infinite amounts of capital will continue to flow in, appreciating the currency. Hence, the only equilibrium possibility is one where the currency is appreciated sufficiently to pull the IS back to its original starting point. Fiscal policy is completely ineffective in affecting output, because of complete crowding out of net exports.

The opposite result is obtained for monetary policy, as shown in Figure 15.11. Expansionary monetary policy shifts out the LM curve (dark gray arrow), resulting in an interest rate below the foreign interest rate. This causes an infinite financial outflow, which in turn depreciates the home currency, spurring net exports. As a consequence, the IS curve shifts out (light gray arrow). However, as long as the IS curve shifts out less than the amount necessary to bring the interest rate up to the foreign interest rate, financial outflows continue, weakening the currency. Only when the IS curve has shifted out sufficiently to set the home interest rate equal to the foreign rate does the process end. Then output will have increased substantially, from  $Y_0$  to  $Y_1$ . Thus with

perfect capital mobility, monetary policy is perfectly effective.

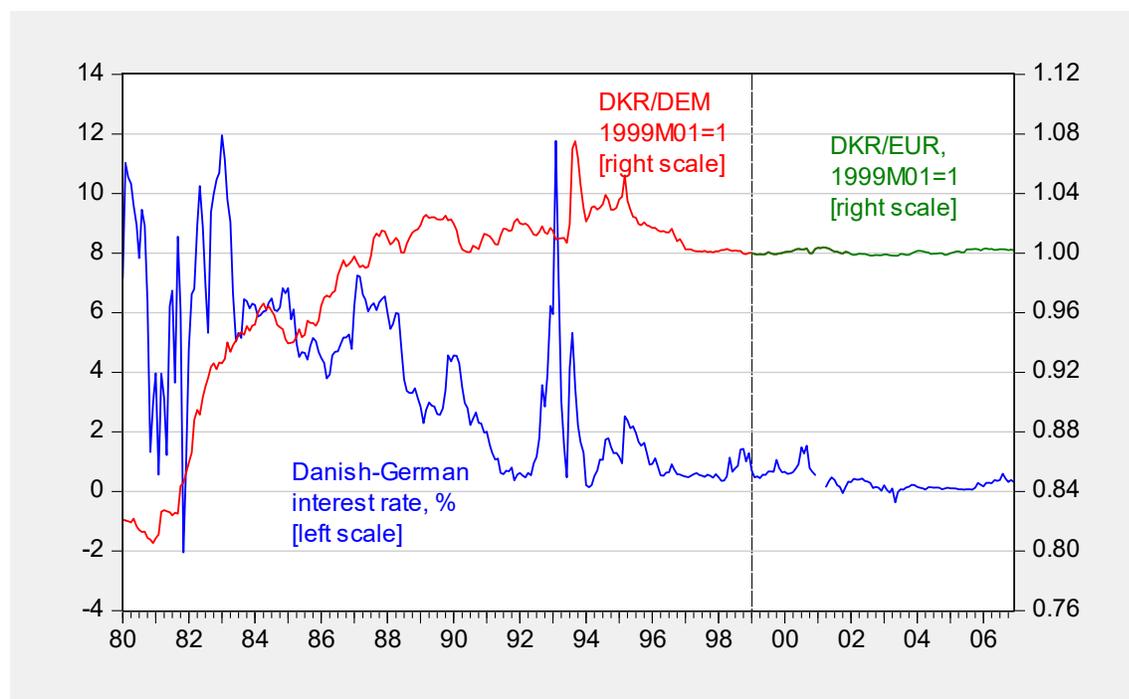


**Figure 15.11:** Perfect capital mobility, with expansionary monetary policy under floating rates

### *Fixed exchange rates*

Interestingly, these results are in turn exactly reversed if the economy is under a *fixed* exchange rate regime. Then fiscal policy is completely effective (because interest changes would induce infinite financial inflows or outflows that cannot be sterilized, and hence change the money base until the original interest rate is restored). Monetary policy is completely ineffective, because any move that shifts the LM curve induces an interest rate change. This triggers either infinite financial inflows or infinite outflows, which undo the original money base change.

Is there an example of a completely fixed exchange rate regime, combined with completely open financial accounts, by which to assess whether an independent monetary policy is possible in such circumstances? The euro area countries, which have given up their own currencies, constitute an extreme example. A less extreme case, where the country retains its own currency, is Denmark, which from approximately 1988 onward has had no cross-border capital controls. As shown in Figure 15.12, when the exchange rate is not pegged, the Danish interest rate can deviate from the German. When Denmark effectively pegs in 1987 to first the German mark and then euro, the interest differential shrinks. When the peg becomes credible in 1997, the interest differential becomes essentially constant at zero.



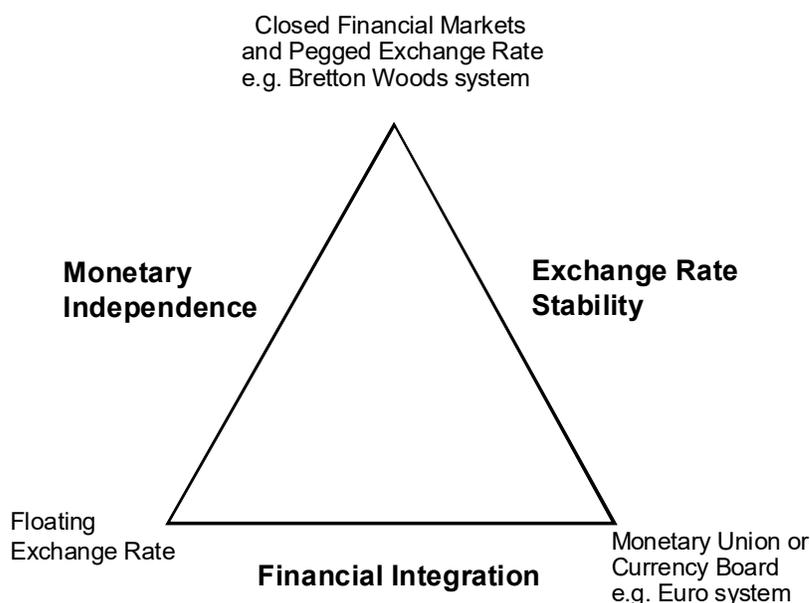
**Figure 15.12:** Danish money market interest rate minus German money market interest rate, in percent (blue, left scale), Danish kroner per German mark (red), and Danish kroner per euro (green), both 1999M01=1 (right scale). Vertical dashed line at 1999M01 represents inception of the euro. Source: IMF, *International Financial Statistics*, and Federal Reserve System.

Notice the interest differential is not exactly zero to begin with; that's because at the beginning, there is some expected probability of devaluation of the krone. Remember, the expected depreciation is what the interest differential should equal under uncovered interest parity (when financial capital is perfectly mobile).

## 15.6 The International Trilemma

The **International Trilemma** is the hypothesis that a country may simultaneously pursue any two, but not all three, of these goals: monetary independence, exchange rate stability, and financial integration.<sup>5</sup> This conclusion leaps out from our discussion of perfect capital mobility in the previous section. The trilemma is illustrated in Figure 15.13, where at each vertex of the triangle two goals are realized but the third is out of reach. Because the three goals are not all simultaneously attainable, they are sometimes called the Impossible Trinity.

<sup>5</sup> The term "international trilemma" was first coined by Obstfeld and Taylor (1997).



**Figure 15.13:** The International Trilemma

**Monetary independence** means that the monetary authorities of an economy are, as it were, masters of their own fate. An economy with a high degree of monetary independence can be stabilized through monetary policy without being at the mercy of other economies' macroeconomic management. Hence, monetary independence can in principle allow countries to stabilize output in the face of developments in the rest of the world economy.

**Exchange rate stability** – at the extreme, keeping the nominal value of a currency fixed against a specific foreign currency -- is a means of providing a nominal anchor. One of the potential benefits of such an anchor is enhanced price stability. In addition, during times of an economic stress, a pegged exchange rate can enhance policy makers' credibility and soothe investor anxieties. However, high levels of exchange rate fixity deprive the economy of the use of the exchange rate as a shock absorber.

**Financial integration** with foreign markets allows more efficient resource allocation, mitigates information asymmetry, and enhances and/or supplementing domestic savings. However, it subjects the economy to the whims of volatile cross-border financial flows. "Sudden stops" – dramatic reversals of financial flows -- have led to boom-bust cycles in numerous smaller economies, particularly in the past three decades. This point is discussed at further length in Chapter 18.

Throughout history, various international financial arrangements have pursued different two-out-of-three combinations of policy goals. The **Bretton Woods system**, which prevailed in the post-World War II period, sacrificed capital mobility for monetary autonomy and exchange rate stability; it is shown at the top of the triangle in Figure 15.13. Until a couple of decades ago, developing countries similarly pursued monetary independence and exchange rate stability, but largely kept their financial markets closed to foreign investors. (See the case of China, recounted in Chapter 14.)

The euro system is built upon the fixed exchange rate arrangement and free capital mobility, but member countries give up monetary autonomy; hence this system is placed at the lower right vertex. The freely floating exchange rate regime (lower left) best characterizes the United States, as well as the euro area as a whole, to the extent that policymakers in these economies do not systematically intervene in foreign exchange markets to manage their currencies.

### *Empirical evidence of the trilemma*

Does the trilemma apply in the real world? To answer that question, Joshua Aizenman, Menzie Chinn and Hiro Ito (2010) constructed operationalized measures of the degree to which each goal in the Impossible Trinity is reached.

Monetary independence is gauged by the correlation of interest rates with those in a major country. If a country's interest rate moves in perfect tandem, percentage point for percentage point, with the rate in, say, the United States, then the degree of monetary independence is zero. If, at the other extreme, there is zero correlation, then there is full monetary independence, value one.

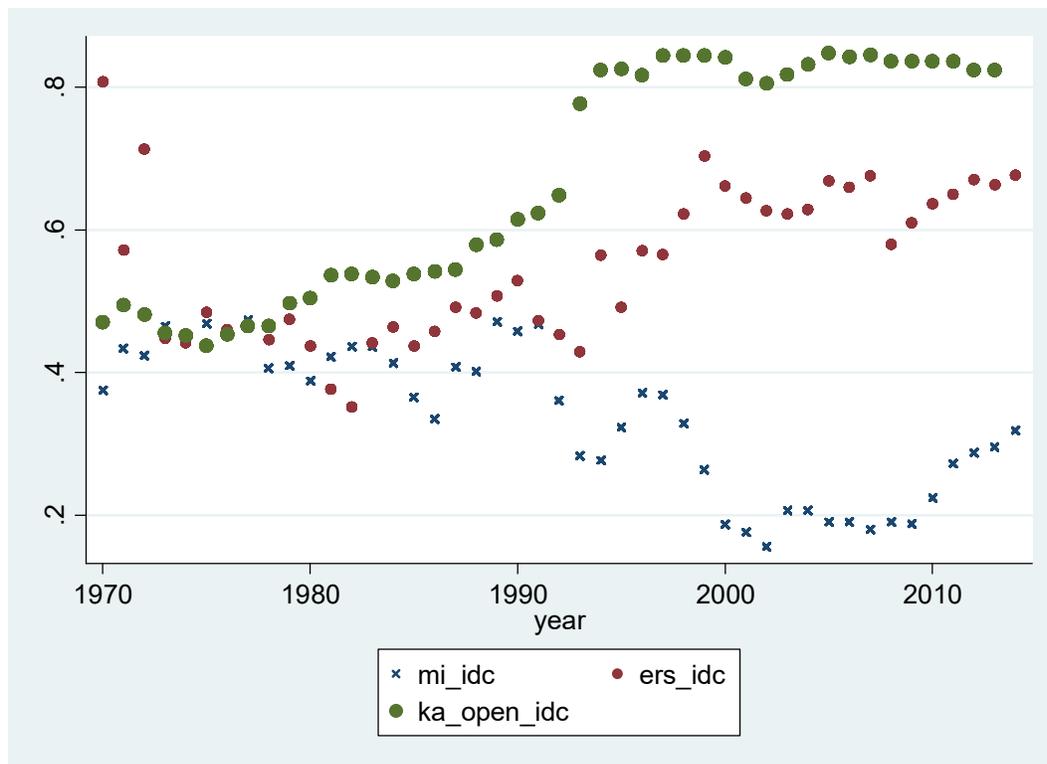
Exchange rate stability is the inverse of exchange rate volatility. Suppose the standard deviation of month-to-month changes in the exchange rate against a reference currency (such as the U.S. dollar) is zero; then the exchange rate is fully stable.

Finally, capital mobility is measured using an index based on the legal restrictions on cross-border transactions, as reported by each country to the International Monetary Fund. Chinn and Ito calculate an index of financial openness that takes on a value of one if there are no restrictions, and a value of zero if there are very tight restrictions.

Applying these variable measures to a large set of industrialized countries, for data covering the period 1970–2014, Aizenman, Chinn and Ito found that countries do face a trilemma. As one of the three goals is favored, one of the two other goals has to be sacrificed—and sometimes both.<sup>6</sup> The evolution of the three indices, averaged over the countries studied, is shown in Figure 15.14.

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<sup>6</sup> In a related study, Klein and Shambaugh (2013) documented that central banks are freer to set their interest rates the more flexible the exchange rate regime is, or the more stringent restrictions on financial capital flows are.



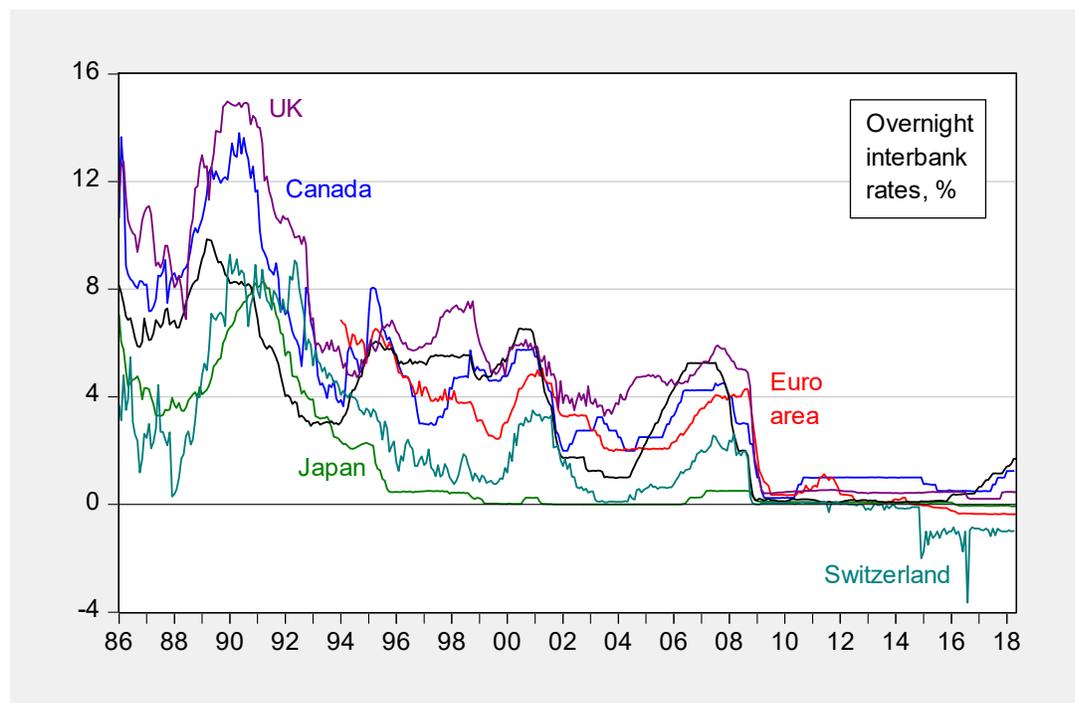
**Figure 15.14:** Monetary independence (mi), exchange rate stability (ers), and capital mobility (ka open) indices, averages for all industrial countries.

The patterns in the data demonstrate that since the breakdown of the Bretton Woods system in 1971, industrialized countries have loosened the constraints on the free flow of financial capital and stabilized exchange rates, while abdicating monetary autonomy. Some of the movement that occurs in 2000 is due to the advent of the **Economic and Monetary Union (EMU)**, popularly known as the creation of the euro. EMU entailed the surrender of independent currencies, and hence the abandonment of independent monetary policies.

In sum, the theoretical framework laid out in Chapter 14 and this chapter are verified in the real world. When exchange rates are fixed and capital mobility is high, as in the case of Denmark, then monetary autonomy is limited. On the other hand, as in the case of China (as discussed in Chapter 14), when impediments to financial flows are high, countries can retain both rigid exchange rates and an independent monetary policy.

### 15.7 Another Limit to Monetary Policy Effectiveness

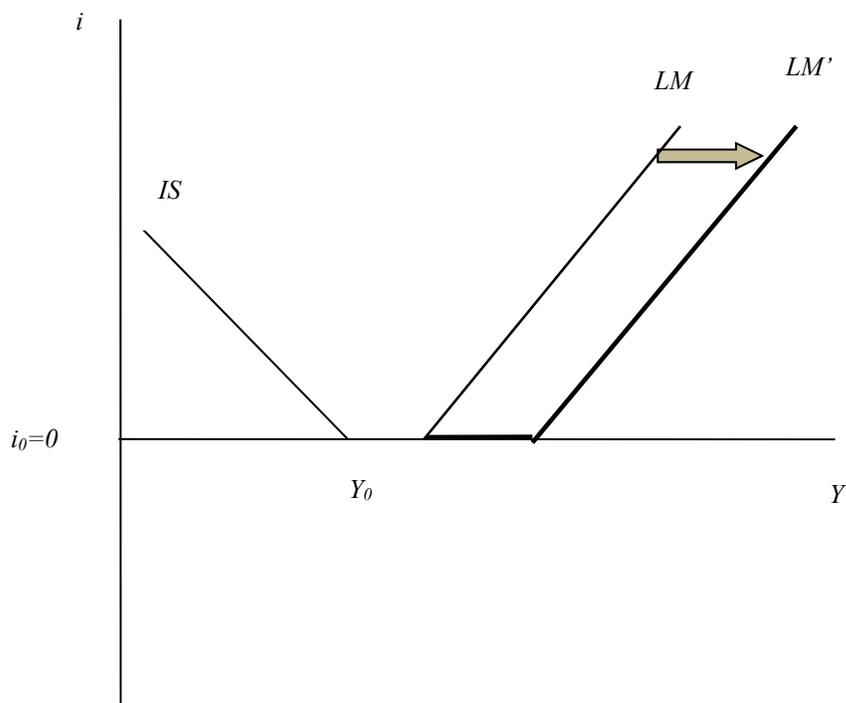
Even in circumstances where the exchange rate is not fixed, it may still happen that monetary policy is perfectly ineffective. For most of the post-World War II era, monetary policy has been able to spur output, including net exports, by dropping the interest rate, thereby boosting investment. However, as the 21<sup>st</sup> century got under way, central banks seeking to stimulate economic growth began to encounter the **zero lower bound**, where bonds no longer pay any interest at all. As Figure 15.15 shows, Japan was the first to run up against this limit, around 2000. In 2008, as the world fell into recession, the U.S., the UK, and the euro area followed suit.



**Figure 15.15:** Overnight interbank interest rates in U.S. (black), Canada (blue), euro area (red), Japan (green), United Kingdom (purple) and Switzerland (teal). Source: IMF, OECD.

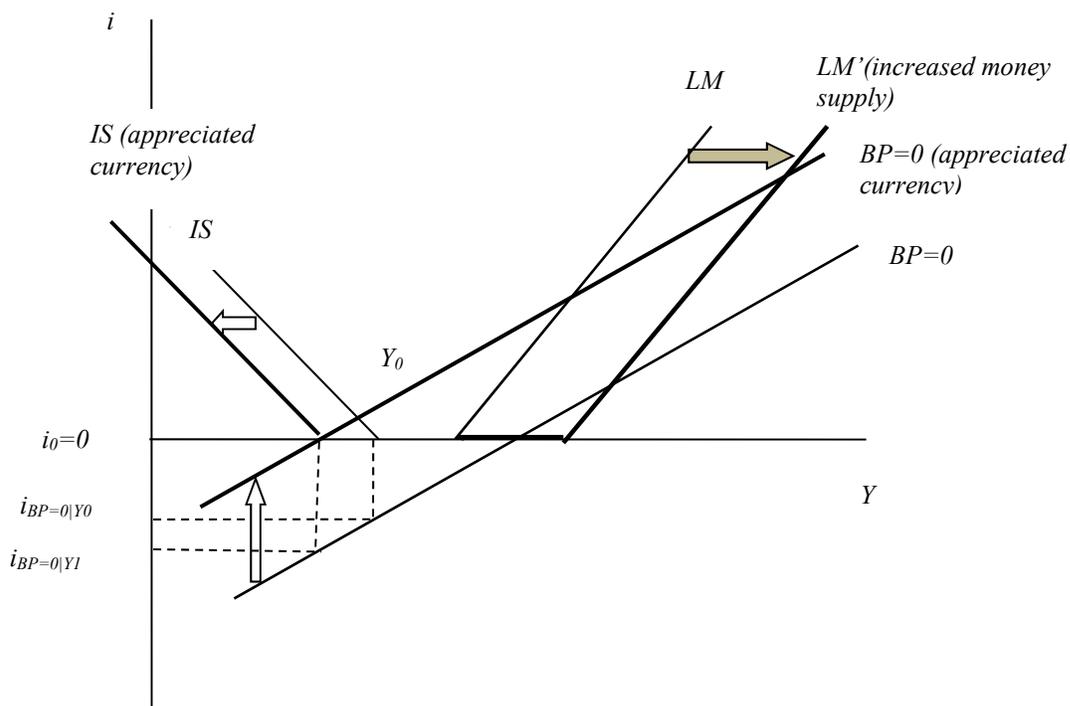
When bonds pay no interest, actors holding money have no incentive to buy bonds; they would be giving up liquidity and getting nothing in return. Therefore, would-be capital investors are deprived of a main means of raising the necessary funds, and so the economy is deprived of output-boosting production capital. This situation is termed a **liquidity trap**, because it represents conditions under which ordinary monetary policy ceases to be an effective tool for stimulating income growth. Getting out of the trap requires extraordinary measures, which penalize holders of money by imposing negative interest rates.

To represent this situation using our model, we must modify the IS and LM curves to reflect that fact that it is very difficult to move interest rates below 0%. At  $i = 0$ , the two curves must flatten out as shown in Figure 15.16. For the sake of illustration, we initially ignore the  $BP=0$  schedule. The money supply is sufficiently large so that the IS curve intersects the LM curve on the flat portion, at  $Y_0$ . Under those conditions, an increase in the money supply (gray arrow) doesn't have any effect on the interest rate; it remains at zero.



**Figure 15.16:** Monetary policy in the liquidity trap

In order to examine how the presence of a liquidity trap affects the effectiveness of monetary policy in an open economy, we now re-introduce the  $BP=0$  schedule, as shown in Figure 15.17.



**Figure 15.17:** Non-adjustment in a liquidity trap

Notice that the equilibrium interest rate is above the rate that equilibrates the balance of payments. As a consequence, the currency appreciates, shifting up the BP=0 schedule, and shifting in the IS curve. Output falls to  $Y_1$ .

Interestingly, not only is monetary policy ineffective in boosting output. Over time, the adjustment process leads to a reduction of output. For this reason, the presence of a liquidity trap poses an especially difficult obstacle to stimulating the economy in the face of an economic contraction.

This challenge arises because of the placement of the BP=0 schedule. The BP=0 schedule could be placed higher; in that case, the equilibrium interest rate would be below that necessary for external balance. The currency would depreciate, shifting the IS curve out and the BP=0 curve down. Then equilibrium would be re-established by the adjustment process.

Which situation is more likely to prevail? As shown in Figure 15.15, interest rates of advanced countries were fairly low, if not effectively zero, from 2008 onward. During this period, monetary policy working through the short-term interest rate was ineffective, exactly because the situation illustrated in Figure 15.17 prevailed.

Notice that expansionary *fiscal* policy could be effective in raising output. Appreciation of the currency, arising from the higher interest rate, would tend to offset some of the expansion, but overall, output would increase.

### Box 15.1 Negative Interest Rates

How can interest rates become negative? That surely seems counter-intuitive, since it means that individuals and firms have to pay a fee to deposit their savings in a private bank. Here, we explain how interest rates can become negative. In order to do so, we'll have to explain the linkage between the money base – what the central bank controls – and the money supply.

As discussed in Chapter 12, the central bank only *directly* controls what is called the money base, the sum of currency and bank reserves. Bank reserves are the funds that private banks own but are on reserve with the central bank. For every dollar deposited in a private bank, by regulation a certain portion cannot be loaned out, but must rather be kept on reserve. Private banks can also hold reserves in excess of the required amount.

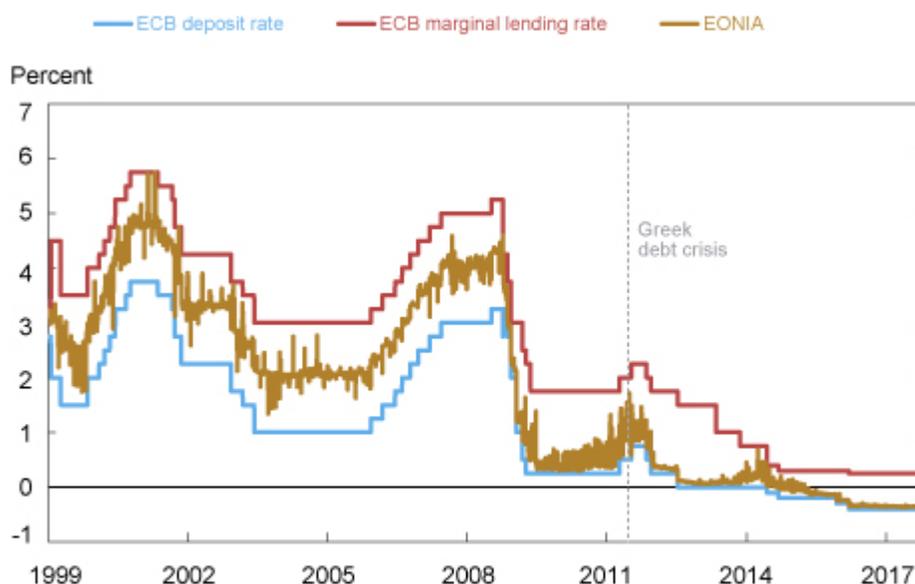
Now consider how the central bank typically controls the interest rate. It sets a deposit interest rate that the central bank pays to banks on excess reserves held overnight in the banks' accounts with the central bank, and a lending rate at which banks could borrow overnight from the central bank. The deposit rate sets a lower bound on the interest rate at which banks lend to each other – why would one bank lend to another at 2.5% if the first bank could instead earn 3% by depositing the money with the central bank? The borrowing rate likewise sets a ceiling – why would a bank borrow from another bank at 5.5% if the central bank will lend any desired amount at 5%? This will keep the interest rate between

these two rates, in what is called “the corridor system.” The central bank can buy or sell government securities to affect the amount of reserves in the system, thereby determining the actual interest rate within the corridor.

Now suppose that instead of a positive deposit rate, the central bank sets a negative rate. Individual banks will try to avoid the cost now associated with central bank deposits. If Bank A, facing the prospect of being charged 0.1% annually sees a 3-month government security paying, say, 0.2%, that bank will want to purchase the security on the open market, thereby replacing a 0.1% loss with a 0.2% gain. But Bank B, which sold the security to Bank A, will realize that with the money it received, it'd be better off getting the 0.2% return than paying 0.1%, so it will also be buying any short-term securities that yield 0.2%, in hopes of not getting stuck paying a fee on deposits. In the end, some bank somewhere will be left, at the end of the day, paying the 0.1% fee.<sup>7</sup> Either that, or with all those banks trying to purchase short-term government securities, the price of short-term government securities will get bid up, until the return on those securities is also negative.

The European Central Bank (ECB) has implemented a negative interest rate policy since June 2014. Figure 15.18 gives a graphical depiction of the operation of the corridor system; the marginal lending facility rate is the equivalent of the discount rate, EONIA is the overnight interest rate banks charge each other.

### EONIA Never Exceeds Marginal Lending Facility Rate



Sources: European Central Bank; Bloomberg L.P.

Note: EONIA is Euro Overnight Index Average.

Source: Lee and Sarkar (2018)

**Figure 15.18:** The Corridor System and Negative Interest Rates

<sup>7</sup> It's infeasible to just hold cash, because there simply isn't enough physical cash in existence. In addition, such large amounts of physical cash would be risky to hold. Only when the fees becomes substantial will banks opt to hold large stocks of cash, thereby putting a lower bound on the negative interest rates that can be imposed.

There is a limit, however, to how far below zero interest rates can be driven. At some point, the penalty rate charged on deposits at the central bank will induce private banks to lend out the funds, instead of holding them as excess reserves. To date, no major central bank has set interest rates below  $-1\%$  on a sustained basis.

## 15.8 Conclusion

When an economy operates under a floating exchange rate regime, the central bank commits to allowing market conditions to fully determine the value of the currency. Implied is that the central bank's stock of foreign exchange reserves should be constant, while the exchange rate adjusts in response to changes in exogenous variables, like government spending, the money supply, and foreign income and interest rates.

Compared to fixed exchange rates, flexible exchange rates leave fiscal policy with less influence on output, because there are now two channels of crowding out: higher interest rates reduce investment and, by appreciating the currency, also reduce net exports. Conversely, with flexible rates monetary policy gains in effectiveness. This occurs because expansionary monetary policy, by changing the interest rate, now affects two components of aggregate demand: investment and net exports.

As the degree of capital mobility increases, the polarity in effectiveness between fiscal and monetary policy becomes more and more pronounced. At the limit, when capital mobility is perfect, so that the smallest of interest differentials triggers infinite flows of capital, with flexible exchange rates fiscal policy becomes completely ineffective and monetary policy perfectly effective.

The International Trilemma is a consequence of the Mundell-Fleming model. If financial integration is complete, then a country can pursue monetary autonomy by allowing exchange rates to float, or it can pursue fixed rates while giving up monetary independence. On the other hand, by giving up financial integration, a country could pursue fixed exchange rates and monetary independence at the same time. What is not possible is simultaneously achieving all three goals—exchange rate stability, monetary autonomy and financial integration.

### Summary Points

1. In a flexible exchange rate regime, the exchange rate adjusts so that changes in foreign exchange reserves are zero.
2. Under a flexible exchange rate regime, when financial capital mobility is relatively high, fiscal policy is relatively less effective and monetary policy more effective, as compared to a fixed rate regime.
3. When a country faces higher foreign interest rates, a higher rate of expected currency depreciation, or an exogenously lower amount of financial inflows, the exchange rate will

tend to depreciate, in the absence of a tightening monetary policy.

4. If monetary policy is tightened in response to a balance of payments deficit, the economy will tend to contract.
5. Under full capital mobility, with a fixed exchange rate regime, monetary policy is completely ineffective and fiscal policy completely effective. With a flexible rate regime, the reverse becomes true.
6. By the International Trilemma, an economy cannot simultaneously achieve financial openness, exchange rate stability and monetary policy autonomy. At best two out of three of those goals can be realized.
7. When the economy is in a liquidity trap, monetary policy will be completely ineffective in increasing output.

### Key Concepts

Bretton Woods system	monetary independence
cyclically adjusted budget balance	perfect capital mobility
Economic and Monetary Union	International Trilemma
exchange rate stability	liquidity trap
financial integration	zero lower bound

### Review Questions

1. Under a pure floating exchange rate regime, official reserves transactions are always zero, so that the economy is always on the  $BP=0$  schedule. What variable or variables adjust(s) in order to insure that this condition holds?
2. Under a pure floating exchange rate regime, is overall economy-wide equilibrium always characterized by all three curves intersecting at the same point (in contrast to what is true in a fixed rate regime)? Why or why not?
3. Under a pure floating exchange rate regime, and relatively high financial capital mobility, will fiscal policy be less or more effective in affecting output? Compare two economies identical except for one is completely closed (no exports or imports, and no borrowing and lending from the rest of the world).

4. Under a floating rate regime, is the central bank able to affect the exchange rate, despite the fact that it is committed to not intervening in the foreign currency market?
5. Is it possible to conduct an independent monetary policy if the exchange rate is fixed, but the degree of capital mobility is zero?
6. Suppose capital mobility is infinite. Can a country simultaneously pursue a fixed exchange rate regime and an independent monetary policy?

### Exercises

1. Suppose the economy is described by the following set of equations, as in the Mundell-Fleming model.

$$(1) \quad Y = \bar{\alpha}[\bar{A} + \bar{X} - \bar{IM} + (n + v)\bar{q}] - bi \quad \text{<IS curve>}$$

$$(1') \quad i = \frac{\bar{A} + \bar{X} - \bar{IM} + (n + v)\bar{q}}{b} - \left(\frac{1 - c + m}{b}\right) Y \quad \text{<IS curve>}$$

$$(2) \quad i = -\left(\frac{1}{h}\right)\left(\frac{\bar{M}}{\bar{P}}\right) + \left(\frac{k}{h}\right) Y \quad \text{<LM curve>}$$

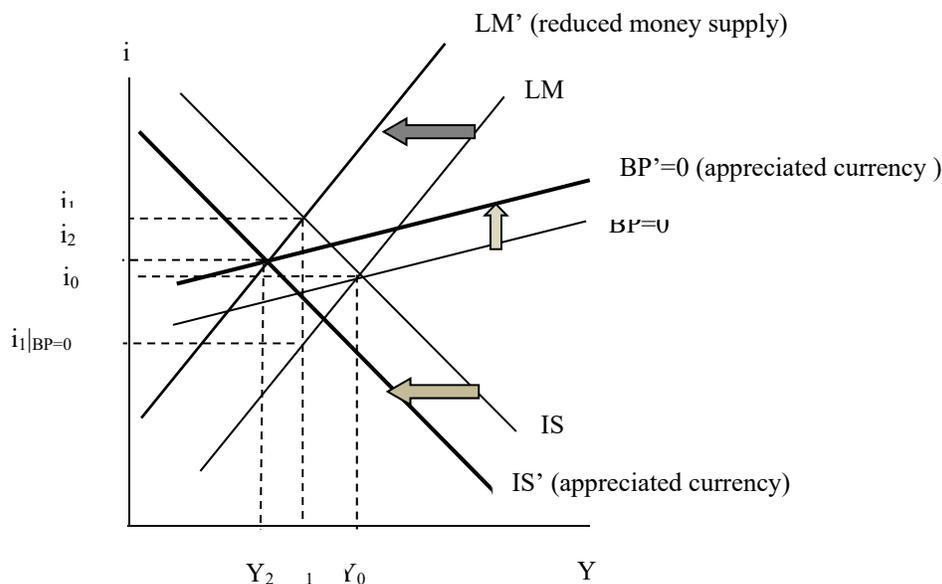
$$(3) \quad i = -\left(\frac{1}{\kappa}\right)[(\bar{X} - \bar{IM} + \bar{FA}) + (n + v)\bar{q}] + \bar{i}^* + \left(\frac{m}{\kappa}\right) Y \quad \text{<BP=0 curve>}$$

- a. Draw a graph of initial equilibrium, where the goods and money markets are in equilibrium, as is the balance of payments. Assume that  $m/\kappa < k/h$ .
  - b. Show what happens if government spending is decreased, both immediately and over time. You might wish to break the answer up into two steps.
  - c. At the new equilibrium, what is true about (i) the level of output; (ii) the level of investment; (iii) the real exchange rate; and (iv) the trade balance?
2. Consider the economy discussed in Exercise 1.
- a. Draw a graph of initial equilibrium, where the goods and money markets are in equilibrium, as is the balance of payments. Show the impact of a monetary contraction, both immediately and over time.
  - b. Explain why the process you lay out in part a occurs.
  - c. Does your answer to part b change if  $m/\kappa > k/h$ ?
3. Consider the same economy described in Exercise 1.
- a. Assume the economy begins in equilibrium. Show what happens in the short term if the foreign interest rate falls exogenously. What happens to output, the interest rate, and the exchange rate?

- b. Suppose the central bank wishes to maintain output at pre-shock levels. What policies can it implement to achieve that goal?
4. Consider the same economy described in Exercise 1.
- Assume the government wishes to reduce the trade deficit by imposing tariffs to decrease the amount of autonomous imports,  $\overline{IM}$ . Graphically show the impact on output and interest rates.
  - Does the trade balance improve by the amount that autonomous imports decrease?
5. Consider a closed version of the economy in Exercise 1. Exports and imports are both zero, and no financial capital flows cross the border.
- Suppose the economy is in a liquidity trap. Show the impact of a decrease in government spending. Is fiscal policy effective in changing output?
  - Suppose the economy is in a liquidity trap. Show the impact of a decrease in the money supply, if the resulting interest rate is positive. Is monetary policy effective in changing output?
6. Consider the economy described in Section 15.5, with the equilibrium interest rate below the interest rate consistent with balance of payments equilibrium.
- Illustrate the initial equilibrium.
  - Show how the economy adjusts over time.
7. Consider the Mundell-Fleming model, with infinite capital mobility. Show each of the following, using a diagram:
- The impact of contractionary fiscal policy under fixed exchange rates.
  - The impact of contractionary monetary policy under floating exchange rates.
  - The impact of contractionary fiscal policy under floating exchange rates.
  - The impact of contractionary monetary policy under fixed exchange rates.

### Worked Exercise

2. Consider the economy discussed in Exercise 1.
- Draw a graph of initial equilibrium, where the goods and money markets are in equilibrium, as is the balance of payments. Show the impact of a monetary contraction, both immediately and over time.

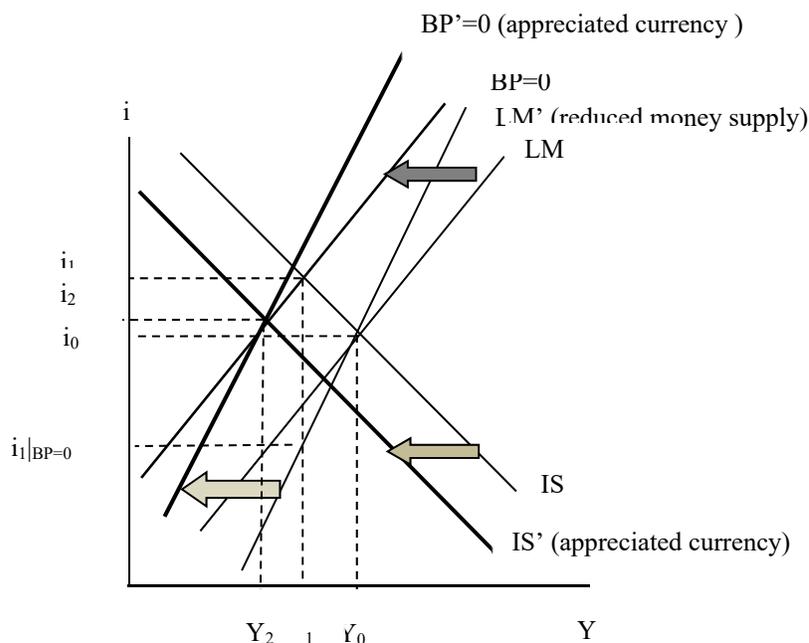


The initial monetary contraction shifts in the LM curve (dark gray arrow). As a consequence, the IS curve shifts in, the  $BP=0$  curve shifts up.

b. Explain why the process you lay out in 2.a occurs.

The shift in of the LM curve would raise the interest rate to  $i_1$ , which is higher than the interest rate that equilibrates the external accounts,  $i_1|_{BP=0}$ . The incipient balance of payments surplus means that the home currency appreciates; with the price level fixed, the real exchange rate appreciates. This means the trade balance for any given level of income decreases. The interest rate that then equilibrates the external balances for any income level increases – i.e., the  $BP=0$  curve shifts up. At the same time, the appreciated currency means that expenditure switching occurs, so that the IS curve shifts in, until all three curves intersect at the same point. In the end, income has fallen to  $Y_2$ , the interest rate risen to  $i_2$ .

c. Does your answer to 2.b change if  $m/\kappa > k/h$ ?



The essential results do not change. The LM curve shifts in, and again the interest rate  $i_1$  would lead to an incipient balance of payments surplus. The resulting appreciation of the home currency shifts up the  $BP=0$  curve and in the IS curve.

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