Chapter 9, section 3 from the 3rd edition: Policy Coordination*

Carl E. Walsh

March 28, 2017

Contents

1 Policy Coordination **1**

1.1 The Basic Model 2

1.2 Equilibrium with Coordination 6

1.3 Equilibrium without Coordination 7

1 Policy Coordination

An important issue facing economies linked by trade and capital flows is the role to be played by policy coordination. Monetary policy actions by one country will affect other countries, leading to spillover effects that open the possibility of gains from policy coordination. As demonstrated in the previous section, the real effects of an unanticipated change in the nominal money supply in the two-country model depend on how $m - m^*$ is affected. A rise in m, holding m^* unchanged, will produce a home country depreciation, shifting world demand toward the home country's output. With preset prices and output demand determined, the exchange-rate movement represents an important channel through which a monetary expansion affects domestic output. If both monetary authorities attempt to generate output expansions by increasing their money supplies, this exchange-rate channel will not operate, since the exchange rate depends on the relative money supplies. Thus, the impact of an unanticipated change in m depends critically on the behavior of m^*.

This dependence raises the issue of whether there are gains from coordinating monetary policy. Hamada (1976) is closely identified with the basic approach that has been used to analyze policy coordination, and in this section, develops a version of his framework. Canzoneri and Henderson (1989) provided an extensive discussion of monetary policy coordination issues; a survey is provided by Currie and Levine (1991).

Consider a model with two economies. Assume each economy's policy authority can choose its inflation rate and, because of nominal rigidities, monetary policy can have real effects in the short run. In this context, a complete specification of policy behavior is more complicated than in a closed-economy setting; one must specify how each national policy authority interacts strategically with the other policy authority. Two possibilities are considered. Coordinated policy is considered first, meaning that inflation rates in the two economies are chosen jointly to maximize a weighted sum of the objective functions of the two policy authorities. Noncoordinated policy is considered second, with the policy authorities interacting in a Nash equilibrium. In this setting, each policy authority sets its own inflation rate to maximize its objective function, taking as given the inflation rate in the other economy. These clearly are not the only possibilities. One economy may act as a Stackelberg leader, recognizing the impact its choice has on the inflation rate set by the other economy. Reputational considerations along the lines studied in chapter 6 can also be incorporated into the analysis (see Canzoneri and Henderson (1989)).

1.1 The Basic Model

The two-country model is specified as a linear system in log deviations around a steady state and represents an extension to the open-economy environment of the sticky-wage, AS-IS model of chapter 6. The LM relationship is dispensed with by assuming that the monetary policy authorities in the two countries set the inflation rate directly. An asterisk will denote the foreign economy, and ρ will be the real exchange rate, defined as the relative price of home and foreign output, expressed in terms of the home currency; a rise in ρ represents a real depreciation for the home economy. If s is the nominal exchange rate and $p(h)$ and $p^*(f)$ are the prices of home and foreign output, then $\rho = s + p^*(f) - p(h)$. The model should be viewed as an approximation that is appropriate when nominal wages are set in advance so that unanticipated movements in inflation affect real output. In addition to aggregate supply and demand relationships for each economy, an interest parity condition links the real interest-rate differential to anticipated changes in the real exchange rate:

$$y_t = -b_1\rho_t + b_2\left(\pi_t - \mathrm{E}_{t-1}\pi_t\right) + e_t \tag{1}$$

$$y_t^* = b_1\rho_t + b_2\left(\pi_t^* - \mathrm{E}_{t-1}\pi_t^*\right) + e_t^* \tag{2}$$

$$y_t = a_1\rho_t - a_2 r_t + a_3 y_t^* + u_t \tag{3}$$

$$y_t^* = -a_1\rho_t - a_2 r_t^* + a_3 y_t + u_t^* \tag{4}$$

$$\rho_t = r_t^* - r_t + \mathrm{E}_t\rho_{t+1}. \tag{5}$$

Equations (1) and (2) relate output to inflation surprises and the real exchange rate. A real exchange-rate depreciation reduces home aggregate supply by raising the price of imported materials and by raising consumer prices relative to producer prices. This latter effect increases the real wage in terms of producer prices. Equations (3) and (4) make demand in each country an increasing function of output in the other to reflect spillover effects that arise as an increase in output in one country raises demand for the goods produced by the other. A rise in ρ_t (a real domestic depreciation) makes domestically produced goods less expensive relative to foreign goods and shifts demand away from foreign output and toward home output.

To simplify the analysis, the inflation rate is treated as the choice variable of the policymaker. An alternative approach to treating inflation as the policy variable would be to specify money demand relationships for each country and then take the nominal money supply as the policy instrument. This would complicate the analysis without offering any new insights.

A third approach would be to replace r_t with $i_t - \mathrm{E}_t\pi_{t+1}$, where i_t is the nominal interest rate, and treat i_t as the policy instrument. An advantage of this approach is that it more closely reflects the way most central banks actually implement policy. Because a number of new issues arise under nominal interest rate policies (see section **??** and chapter 8), policy is interpreted as choosing the rate of inflation in order to focus, in this section, on the role of policy coordination. Finally, a further simplification is reflected in the assumption that the parameters (the $a_i's$ and $b_i's$) are the same in the two countries.

Demand (u_t, u_t^*) and supply (e_t, e_t^*) shocks are included to introduce a role for stabilization policy. These disturbances are assumed to be mean zero, serially uncorrelated processes, but they are allowed to be correlated to distinguish between common shocks that affect both economies and asymmetric shocks that originate in a single economy.

Equation (5) is an uncovered interest rate parity condition. Rewritten in the form $r_t = r_t^* + \mathrm{E}_t\rho_{t+1} - \rho_t$, it implies that the home country real interest rate will exceed the foreign real rate if the home country is expected to experience a real depreciation.

Evaluating outcomes under coordinated and noncoordinated policies requires some assumption about the objective functions of the policymakers. In models built more explicitly on the behavior of optimizing agents, alternative policies could be ranked according to their implications for the utility of the agents in the economies. Here a common approach is followed in which polices are evaluated on the basis of loss functions that depend on output variability and inflation variability:

$$V_t = \sum_{i=0}^{\infty} \beta^i \left(\lambda y_{t+i}^2 + \pi_{t+i}^2 \right) \tag{6}$$

$$V_t^* = \sum_{i=0}^{\infty} \beta^i \left[\lambda \left(y_{t+i}^* \right)^2 + \left(\pi_{t+i}^* \right)^2 \right]. \tag{7}$$

The parameter β is a discount factor between 0 and 1. The weight attached to output fluctuations relative to inflation fluctuations is λ. While these objective functions are ad hoc, they capture the idea that policymakers prefer to minimize output fluctuations around the steady state and fluctuations of inflation.[1] Objective functions of this basic form have played a major role in the analysis of policy. They reflect the assumption that steady-state output will be independent of monetary policy, so policy should focus on minimizing fluctuations around the steady state, not on the level of output.

The model can be solved to yield expressions for equilibrium output in each economy and for the real exchange rate. To obtain the real exchange rate, first subtract foreign aggregate demand (4) from domestic aggregate demand (3), using the interest parity condition (5) to eliminate $r_t - r_t^*$. This process yields an expression for $y_t - y_t^*$. Next, subtract foreign aggregate supply (2) from domestic aggregate supply (1) to yield a second expression for $y_t - y_t^*$. Equating these two expressions and solving for the equilibrium real exchange rate leads to the following:

$$\begin{aligned} \rho_t \quad = \quad & \frac{1}{B} \left\{ b_2(1+a_3) \left[(\pi_t - \mathrm{E}_{t-1}\pi_t) - (\pi_t^* - \mathrm{E}_{t-1}\pi_t^*) \right] \right. \\ & \left. + (1+a_3)(e_t - e_t^*) - (u_t - u_t^*) + a_2 \mathrm{E}_t \rho_{t+1} \right\}, \end{aligned} \tag{8}$$

where $B \equiv 2a_1 + a_2 + 2b_1(1+a_3) > 0$. An unanticipated rise in domestic inflation relative to unanticipated foreign inflation or in e_t relative to e_t^* will increase domestic output supply relative to foreign output. Equilibrium requires a decline in the relative price of domestic output; the real exchange rate rises (depreciates), shifting demand toward domestic output. If the domestic aggregate demand shock exceeds the foreign shock, $u_t - u_t^* > 0$, the relative price of domestic output must rise (ρ must fall) to shift demand toward foreign output. A rise in the expected future exchange rate also leads to a rise in the current equilibrium ρ. If ρ were to increase by the same amount as the rise in $\mathrm{E}_t\rho_{t+1}$, the interest differential $r_t - r_t^*$ would be left unchanged, but the higher ρ would, from (1) and (2), lower domestic supply relative to foreign supply. So ρ rises by less than the increase in $\mathrm{E}_t\rho_{t+1}$ to maintain goods market equilibrium.[2]

Notice that (8) can be written as $\rho_t = A\mathrm{E}_t\rho_{t+1} + v_t$, where $0 < A < 1$ and v_t is white noise,

[1] The steady-state values of y and y^* are zero by definition. The assumption that the policy loss functions depend on the variance of output around its steady-state level, and not on some higher output target, is critical for the determination of average inflation. Chapter 6 deals extensively with the time-inconsistency issues that arise when policy makers target a level of output that exceeds the economy's equilibrium level.

[2] The coefficient on $\mathrm{E}_t\rho_{t+1}$, a_2/B is less than 1 in absolute value.

since the disturbances are assumed to be serially uncorrelated and the same will be true of the inflation forecast errors under rational expectations. It follows that $\mathrm{E}_t\rho_{t+1} = 0$ in any no-bubbles solution. The expected future real exchange rate would be nonzero if either the aggregate demand or aggregate supply shocks were serially correlated.

Now the expression for the equilibrium real exchange rate can be substituted into the aggregate supply relationships (1) and (2) to yield

$$\begin{aligned} y_t &= b_2 A_1 \left(\pi_t - \mathrm{E}_{t-1}\pi_t\right) + b_2 A_2 \left(\pi_t^* - \mathrm{E}_{t-1}\pi_t^*\right) \\ &\quad - a_2 A_3 \mathrm{E}_t\rho_{t+1} + A_1 e_t + A_2 e_t^* + A_3(u_t - u_t^*) \end{aligned} \tag{9}$$

$$\begin{aligned} y_t^* &= b_2 A_2 \left(\pi_t - \mathrm{E}_{t-1}\pi_t\right) + b_2 A_1 \left(\pi_t^* - \mathrm{E}_{t-1}\pi_t^*\right) \\ &\quad + a_2 A_3 \mathrm{E}_t\rho_{t+1} + A_2 e_t + A_1 e_t^* - A_3(u_t - u_t^*). \end{aligned} \tag{10}$$

The A_i parameters are given by

$$A_1 = \frac{2a_1 + a_2 + b_1(1 + a_3)}{B} > 0$$

$$A_2 = \frac{b_1(1 + a_3)}{B} > 0$$

$$A_3 = \frac{b_1}{B} > 0.$$

Equations (9) and (10) reveal the spillover effects through which the inflation choice of one economy affects the other economy when $b_2 A_2 \neq 0$. An increase in inflation in the home economy (assuming it is unanticipated) leads to a real depreciation. This occurs since unanticipated inflation leads to a home output expansion (see 1). Equilibrium requires a rise in demand for home country production. In the closed economy, this occurs through a fall in the real interest rate. In the open economy, an additional channel of adjustment arises from the role of the real exchange rate. Given that $\mathrm{E}_t\rho_{t+1} = 0$, the interest parity condition (5) becomes $\rho_t = r_t^* - r_t$, so, for given r_t^*, the fall in r_t requires a rise in ρ_t (a real depreciation), which also serves to raise home demand.

The rise in ρ_t represents a real appreciation for the foreign economy, and this raises consumer-price wages relative to producer-price wages and increases aggregate output in the foreign economy (see 2). As a result, an expansion in the home country produces an economic expansion in the foreign country. But as (8) shows, a surprise inflation by both countries leaves the real exchange rate unaffected. It is this link that opens the possibility that outcomes will depend on the extent to which the two countries coordinate their policies.

1.2 Equilibrium with Coordination

To focus on the implications of policy coordination, attention is restricted to the case of a common aggregate supply shock, common in the sense that it affects both countries. That is, suppose $e_t = e_t^* \equiv \varepsilon_t$, where ε_t is the common disturbance. For the rest of this section, assume $u \equiv u^* \equiv 0$, so that ε represents the only disturbance.

In solving for equilibrium outcomes under alternative policy interactions, the objective functions (6) and (7) simplify to a sequence of one-period problems (the problem is a static one with no link between periods). Assuming that the policy authority is able to set the inflation rate after observing the supply shock ε_t, the decision problem under a coordinated policy is

$$\min_{\pi,\pi^*} \left\{ \frac{1}{2} \left[\lambda y_t^2 + \pi_t^2 \right] + \frac{1}{2} \left[\lambda \left(y_t^* \right)^2 + \left(\pi_t^* \right)^2 \right] \right\}$$

subject to (9) and (10).[3] The first-order conditions are

$$\begin{aligned} 0 &= \lambda b_2 A_1 y_t + \pi_t + \lambda b_2 A_2 y_t^* \\ &= \left(1 + \lambda b_2^2 A_1^2 + \lambda b_2^2 A_2^2 \right) \pi_t + 2\lambda b_2^2 A_1 A_2 \pi_t^* + \lambda b_2 \varepsilon_t \end{aligned}$$

$$\begin{aligned} 0 &= \lambda b_2 A_2 y_t + \lambda b_2 A_1 y_t^* + \pi_t^* \\ &= \left(1 + \lambda b_2^2 A_1^2 + \lambda b_2^2 A_2^2 \right) \pi_t^* + 2\lambda b_2^2 A_1 A_2 \pi_t + \lambda b_2 \varepsilon_t, \end{aligned}$$

which uses the fact that $A_1 + A_2 = 1$ and the result that the first-order conditions imply $\mathrm{E}_{t-1}\pi_t = \mathrm{E}_{t-1}\pi_t^* = 0$.[4] Solving these two equations yields the equilibrium inflation rates under coordination:

$$\pi_{c,t} = \pi_{c,t}^* = -\left(\frac{\lambda b_2}{1 + \lambda b_2^2} \right) \varepsilon_t \equiv -\theta_c \varepsilon_t. \tag{11}$$

Both countries maintain equal inflation rates. In response to an adverse supply shock ($\varepsilon < 0$), inflation in both countries rises to offset partially the decline in output. Substituting (11) into the expressions for output and the equilibrium real exchange rate,

$$y_{c,t} = y_{c,t}^* = \left(\frac{1}{1 + \lambda b_2^2} \right) \varepsilon_t < \varepsilon_t$$

[3] In defining the objective function under coordinated policy, we have assumed that each country's utility receives equal weight.

[4] Writing out the first order condition for π_t in full, $0 = \pi_t + \lambda b_2^2 \left(A_1^2 + A_2^2 \right) \left(\pi_t - \mathrm{E}_{t-1}\pi_t \right) + 2\lambda b_2^2 A_1 A_2 \left(\pi_t^* - \mathrm{E}_{t-1}\pi_t^* \right) + 2\lambda b_2 \varepsilon_t$. Taking expectations conditional on time $t-1$ information (i.e., prior to the realization of ε_t), we obtain $\mathrm{E}_{t-1}\pi_t = 0$.

and

$$\rho_t = 0.$$

The policy response acts to offset partially the output effects of the supply shock. The larger the weight placed on output in the loss function (λ), the larger the inflation response and the more output is stabilized. Because both economies respond symmetrically, the real exchange rate is left unaffected.[5]

1.3 Equilibrium without Coordination

When policy is not coordinated, some assumption must be made about the nature of the strategic interaction between the two separate policy authorities. One natural case to consider corresponds to a Nash equilibrium; the policy authorities choose inflation to minimize loss, taking as given the inflation rate in the other economy. An alternative case arises when one country behaves as a Stackelberg leader, taking into account how the other policy authority will respond to the leader's choice of inflation. The Nash case is analyzed here, leaving the Stackelberg case to be studied as a problem at the end of the chapter.

The home policy authority picks inflation to minimize $\lambda y_t^2 + \pi_t^2$, taking π_t^* as given. The first-order condition is

$$\begin{aligned} 0 &= \lambda b_2 A_1 y_t + \pi_t \\ &= \left(1 + \lambda b_2^2 A_1^2\right) \pi_t + \lambda b_2^2 A_1 A_2 \pi_t^* + \lambda b_2 A_1 \varepsilon_t \end{aligned}$$

so that the home country's reaction function is

$$\pi_t = -\left(\frac{\lambda b_2^2 A_1 A_2}{1 + \lambda b_2^2 A_1^2}\right) \pi_t^* - \left(\frac{\lambda b_2 A_1}{1 + b_2^2 A_1^2}\right) \varepsilon_t. \tag{12}$$

A rise in the foreign country's inflation rate is expansionary for the domestic economy (see 9). The domestic policy authority lowers domestic inflation to partially stabilize domestic output. A parallel treatment of the foreign country policy authority's decision problem leads to the reaction function

$$\pi_t^* = -\left(\frac{\lambda b_2^2 A_1 A_2}{1 + \lambda b_2^2 A_1^2}\right) \pi_t - \left(\frac{\lambda b_2 A_1}{1 + \lambda b_2^2 A_1^2}\right) \varepsilon_t. \tag{13}$$

Jointing solving these two reaction functions for the Nash equilibrium inflation rates yields

$$\pi_{N,t} = \pi_{N,t}^* = -\left(\frac{\lambda b_2 A_1}{1 + \lambda b_2^2 A_1}\right) \varepsilon_t \equiv -\theta_N \varepsilon_t. \tag{14}$$

[5] This would not be the case in response to an asymmetric supply shock. See problem 4.

How does stabilization policy with noncoordinated policies compare with the coordinated policy response given in (11)? Since $A_1 < 1$,

$$|\theta_N| < |\theta_c|.$$

Policy responds less to the aggregate supply shock in the absence of coordination, and as a result, output fluctuates more:

$$y_{N,t} = y^*_{N,t} = \left(\frac{1}{1+\lambda b_2^2 A_1}\right)\varepsilon_t > \left(\frac{1}{1+\lambda b_2^2}\right)\varepsilon_t.$$

Because output and inflation responses are symmetric in the Nash equilibrium, the real exchange rate does not respond to ε_t.

Why does policy respond less in the absence of coordination? For each individual policymaker, the perceived marginal output gain from more inflation when there is an adverse realization of ε reflects the two channels through which inflation affects output. First, surprise inflation directly increases real output because of the assumption of nominal rigidities. This direct effect is given by the term $b_2(\pi_t - \mathrm{E}_{t-1}\pi_t)$ in (1). Second, for given foreign inflation, a rise in home inflation leads to a real depreciation (see 8) and, again from (1), the rise in ρ_t acts to lower output, reducing the net impact of inflation on output. With π^* treated as given, the exchange-rate channel implies that a larger inflation increase is necessary to offset the output effects of an adverse supply shock. Since inflation is costly, the optimal policy response involves a smaller inflation response and less output stabilization. With a coordinated policy, the decision problem faced by the policy authority recognizes that a symmetric increase in inflation in both countries leaves the real exchange rate unaffected. With inflation perceived to have a larger marginal impact on output, the optimal response is to stabilize more.

The loss functions of the two countries can be evaluated under the alternative policy regimes (coordination and noncoordination). Because the two countries have been specified symmetrically, the value of the loss function will be the same for each. For the domestic economy, the expected loss when policies are coordinated is equal to

$$L^c = \frac{1}{2}\left(\frac{1}{1+\lambda b_2^2}\right)\lambda\sigma_\varepsilon^2.$$

When policies are determined in a Nash noncooperative equilibrium,

$$L^N = \frac{1}{2}\left[\frac{1+\lambda b_2^2 A_1^2}{(1+\lambda b_2^2 A_1)^2}\right]\lambda\sigma_\varepsilon^2.$$

Because $0 < A_1 < 1$, it follows that $L^c < L^N$; coordination achieves a better outcome than occurs in the Nash equilibrium.

This example appears to imply that coordination will always dominate noncoordination. It is important to recall that the only source of disturbance was a common aggregate supply shock. The case of asymmetric shocks is addressed in problem 2. But even when there are only common shocks, coordination need not always be superior. Rogoff (1985) provided a counterexample. His argument is based on a model in which optimal policy is time inconsistent (see chapter 6), but one can briefly describe the intuition behind Rogoff's results. A coordinated monetary expansion leads to a larger short-run real-output expansion because it avoids changes in the real exchange rate. But this fact increases the incentive to engineer a surprise monetary expansion if the policymakers believe the natural rate of output is too low. Wage and price setters will anticipate this tactic, together with the associated higher inflation. Equilibrium involves higher inflation, but because it has been anticipated, output (which depends on inflation surprises) does not increase. Consequently, coordination leads to better stabilization but higher average inflation. If the costs of the latter are high enough, noncoordination can dominate coordination.

The discussion of policy coordination serves to illustrate several important aspects of open-economy monetary economics. First, the real exchange rate is the relative price of output in the two countries, so it plays an important role in equilibrating relative demand and supply in the two countries. Second, foreign shocks matter for the domestic economy; both aggregate supply and aggregate demand shocks originating in the foreign economy affect output in the domestic economy. As (9) and (10) show, however, the model implies that common demand shocks that leave $u - u^*$ unaffected have no effect on output levels or the real exchange rate. Since these shocks do affect demand in each country, a common demand shock raises real interest rates in each country. Third, policy coordination can matter.

While the two-country model of this section is useful, it has several omissions that may limit the insights that can be gained from its use. First, the aggregate demand and aggregate supply relationships are not derived explicitly within an optimizing framework. As shown in chapter 5 and in the Obstfeld-Rogoff model, expectations of future income will play a role when consumption is determined by forward-looking, rational economic agents. Second, there is no role for current-account imbalances to affect equilibrium through their effects on foreign asset holdings. Third, no distinction has been drawn between the price of domestic output and the price index relevant for domestic residents. The loss function for the policymaker may depend on consumer price inflation. Fourth, the inflation rate was treated as the instrument of policy, directly controllable by the central bank. This is an obvious simplification, one that abstracts from the linkages (and slippages) between the actual instruments of policy and the realized rate of inflation. Although such simplifications are useful for addressing many policy issues, chapters 11 and 12 will examine these linkages in more detail. Finally, the model, like the Obstfeld-Rogoff example, assumed one-period nominal contracts. Such a formulation fails to capture the persistence that generally characterizes actual inflation and the lags between changes in policy and the resulting changes in output and inflation.

References

Canzoneri, M. B., Henderson, D. 1989. Noncooperative Monetary Policies in Interdependent Economies. Cambridge, MA, MIT Press. 1

Currie, D., Levine, P. 1991. The International Co-ordination of Monetary Policy: A Survey. In C. Green, D. Llewellyn eds. Surveys in Monetary Economics, Vol. 1, Cambridge, MA, Balckwell, 379–417. 1

Hamada, K. 1976. A Strategic Analysis of Monetary Interdependence. Journal of Political Economy, 84, 677–700. 1

Rogoff, K. 1985. Can International Policy Coordination Be Counterproductive?. Journal of International Economics, 18, 199–217. 1.3

Walsh, C. E. 2010. Monetary Theory and Policy, Third Edition. Cambridge, MA, The MIT Press, 3rd edition, 640. *