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Volume Title: International Aspects of Fiscal Policies

Volume Author/Editor: Jacob A. Frenkel, ed.

Volume Publisher: University of Chicago Press

Volume ISBN: 0-226-26251-0

Volume URL: http://www.nber.org/books/fren88-1

Publication Date: 1988

Chapter Title: Coordination of Monetary and Fiscal Policies in the Industrial Economies

Chapter Author: Warwick McKibbin, Jeffrey D. Sachs

Chapter URL: http://www.nber.org/chapters/c7924

Chapter pages in book: (p. 73 - 120)

3 Coordination of Monetary and Fiscal Policies in the Industrial Economies

Warwick J. McKibbin and Jeffrey D. Sachs

3.1 Introduction

The volatility of the world economy since the breakdown of the Bretton Woods par value system of exchange rates has led many policymakers and economists to call for reform of the international monetary system. Many economists have argued that domestic macroeconomic policies in the major OECD economies should be geared, at least in part, to maintaining exchange rates within ranges set cooperatively among the major countries. Proposals vary from the "target zone" system, as advocated by Williamson (1983) and Roosa (1984), to a much more stringent system of fixed exchange rates, as advocated by McKinnon (1984). There are several possible arguments in the case for a return to a more managed system, as described in recent surveys by Obstfeld (1985) and Sachs (1985b). One crucial argument has been that the equilibrium of noncooperative macroeconomic policymaking under flexible exchange rates is likely to be inefficient, as countries fail to take into account the external effects of their policies on their trading partners. More rigid rules of the game, as embodied in a managed exchange rate system, are seen as a way to reduce the inducements to beggar-thy-neighbor policies. It has been frequently noted that there are many institutional forms that greater cooperation might take, ranging from the give-and-take of bargaining at economic summit meetings

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The authors thank William Branson and Robert Flood for helpful comments and DRI for computing facilities. Warwick McKibbin thanks the Reserve Bank of Australia for financial support. Any views expressed in this paper do not necessarily reflect those of the institutions with which the authors are affiliated.

to the implicit form of cooperation that takes place when each country adheres to externally imposed exchange rate targets. The exchange rate alternative is seen as particularly attractive in that it reduces the needs for constant, face-to-face bargaining. The hope is that, by changing rules of the game, policymakers can then be free to act independently (i.e., noncooperatively) within the confines of the international agreement. Tighter margins for exchange rate fluctuations might eliminate the most noxious forms of international competition, in the same way that the General Agreement on Tariffs and Trade has significantly reduced the international competition via tariff setting.

There are of course limits to the gains that will be achieved by a change in the international rules of the game. Every set of exchange arrangements will generate its own forms of strategic behavior, which will tend to cause some forms of inefficient strategic behavior. For example, while much of recent writing in this area has considered the gaming aspects of flexible exchange rates (see Canzoneri and Gray 1985, and Buiter and Marston 1985), many other studies have shown that similar strategic issues arise in fixed exchange rate systems. Indeed, the original analytical work in this area, by Hamada (1974), considered the case of monetary management under a fixed exchange rate regime. Even the classical gold standard, the self-regulating system par excellence, offered up incentives for inefficient strategic behavior, as argued by Eichengreen (1985) and Matsuyama (1985). An important task of research in this area is to make quantitative judgments about the gains and losses from alternative forms of exchange rate management.

This paper studies the properties of four alternative international monetary regimes, with respect both to their operating characteristics and to the incentives for strategic behavior under each regime. We consider alternatively a floating exchange rate system and three forms of fixed exchange rate systems. In the floating rate system, we assume that policymakers in each country can choose monetary and fiscal instruments in order to maximize a national social welfare function, without having to gear the policy choices to a particular exchange rate target. In the fixed exchange rate systems, some or all of the countries are required to peg the exchange rate as a side condition on their policy actions. We then study the implications of the exchange rate constraints. However, we do not ask the more fundamental question whether the exchange rate system itself would be viable or whether the countries would instead choose to bow out of the arrangement.

As is well known, a fixed exchange rate system must be specified by much more than the constraint that bilateral or multilateral rates be fixed. It is crucial to specify which countries have the obligation to intervene in order to preserve a given peg. The so-called $N-1$ problem

underlines the fact that in a fixed regime of N countries, only $N-1$ countries need to undertake the obligation to stabilize. The Nth country, presumably, can act without direct regard for the consequences of its policies on the exchange rate. The "problem," generally speaking, is to decide how the responsibilities for pegging are allocated among the countries.

We consider three alternatives that are widely discussed. The first is an asymmetric "dollar standard," in which the United States assumes no responsibility in pegging the exchange rate, while the other countries (specifically Japan, and the rest of the OECD, which we call the ROECD) both peg to the dollar. This system, making the United States the Nth country, is considered by many to be a reasonable description of how the Bretton Woods system actually operated (see Swoboda 1978). In fact, it should be remembered that under the Bretton Woods arrangement, the United States had the side condition to peg the dollar price of gold at $35 per ounce, though it is difficult to find an important effect of this constraint on U.S. policy actions through most of the Bretton Woods period.

The other two systems that we study are symmetric solutions to the $N-1$ problem, à la gold standard. Recently, McKinnon (1984) has proposed a fixed exchange rate arrangement for the United States, Germany, and Japan, in which the cross rates among these countries are fixed, and in which the weighted sum of the money stocks of the three countries is to be held constant. This means that any expansion of money in one country must be matched by a compensating contraction in the other countries. Note that a strict gold standard, with a constant world stock of gold reserves, would work this way: any increase in money in one country (backed 100% by gold reserves) would necessarily require a contraction in money in the rest of the world. Subject to this monetary constraint, the countries would be free to pursue independent fiscal policies.

This monetary standard is extremely strict in making the aggregate stock of world money invariant to underlying conditions. As a third fixed exchange rate arrangement, we experiment with a modified McKinnon plan (dubbed McKinnon II), in which the exchange rates across regions are fixed, but in which the weighted world money stock is controlled cooperatively by the participating countries to forestall large swings in world economic activity. Using a numerical model later, we attempt to find an equilibrium set of rules for fiscal policy in each country and for the global money stock, which has the following properties: the fiscal rules are optimal for each country, taking as given the fiscal rules in the other countries and the rule for the management of the global money stock, while at the same time the cooperative money rule is optimal, taking as given the fiscal rules in each of the countries.

Within each of these exchange rate systems, we analyze the behavior and characteristics of fiscal policy and examine the way changes in the rules of the game affect the incentives to use fiscal and monetary policies. In particular, we seek to determine whether the various inefficiencies of floating rates caused by the strategic behavior of individual countries can be muted by a move to a more managed system. Under various circumstances, a move to managed rates can indeed blunt the inefficient deployment of fiscal policies, but we also find that there are many circumstances in which the introduction of fixed rates would itself lead to serious inefficiencies of other sorts. As is common in this kind of research, the desirability of one type of monetary arrangement over another will depend to an important extent on the nature of the underlying shocks hitting the world economy.

In section 3.2 we examine the transmission of fiscal policies under alternative exchange rate arrangements, using an extremely simple version of the Mundell-Fleming model for heuristic purposes. We then move on to a large-scale empirical model of the world economy in section 3.3, in which the same fiscal experiments are performed. We find that the cross-country transmission of fiscal policy is affected in crucial quantitative ways according to the global monetary arrangements in which the fiscal expansion takes place. In section 3.4 we take up the strategic aspects of monetary and fiscal policies under the alternative monetary arrangements that we are examining, and present illustrations in which a return to fixed rates would indeed raise the efficiency of macroeconomic management. In section 3.5 the large-scale empirical model is then used to study strategic aspects of policymaking in a differential game format. We examine a game of disinflation, in which all of the major economies begin the game with an excessively high inflation rate and in which all then use monetary and fiscal policies (subject to the rules of the exchange regime) in order to disinflate optimally. Once again we confirm the crucial quantitative importance of alternative exchange regimes for policy choices and macroeconomic outcomes. Finally, in section 3.6 we introduce a useful methodology for judging the long-run efficiency of alternative forms of monetary arrangements. Some concluding remarks are offered in section 3.7.

3.2 Fiscal Policy Transmission in a Simple Mundell-Fleming Model

We now introduce a simple, static, two-country model in order to illustrate the implications for fiscal policy of alternative monetary regimes. We introduce the barest-bones model here for illustrative purposes only, since in section 3.3 we study a richly specified and empirically calibrated model of the world economy. It turns out, however,

that even the simplest fixed-price model can give us a good understanding of the properties of the short-run policy multipliers in the large-scale model.

Consider the following standard setup, as in Mundell (1968). We assume that domestic and foreign goods prices (p and p^*) are fixed, and that there is perfect capital mobility ($i = i^*$). The exchange rate (e) between the two countries is in units of the home currency per unit of foreign currency. An asterisk (*) denotes foreign country. The model is specified with two money demand equations, and two IS curves. The notation is standard: m is (log) money balances; p is (log) prices; q is (log) output; i is the nominal interest rate; and g is the measure of fiscal policy. The equations are as follows:

$$m - p = \phi q - \beta i \tag{1}$$

$$m^* - p^* = \phi q^* - \beta i \tag{2}$$

$$q = -\delta(p - e - p^*) - \sigma i + \lambda g + \gamma q^* \tag{3}$$

$$q^* = \delta(p - e - p^*) - \sigma i + \lambda g^* + \gamma q \tag{4}$$

We assume, as is standard, that the interaction term in the IS equations, γ, is positive and less than one in value. We consider four monetary regimes and study the fiscal policy multipliers in each case. The regimes are:

(a) floating exchange rate (the change in the exchange rate, de, is unrestricted, and pure fiscal policy is studied with $dm = dm^* = 0$);
(b) dollar standard (U.S. monetary policy is held fixed, so that $dm = 0$ and the foreign money supply adjusts endogenously so that $de = 0$);
(c) McKinnon rule (the exchange rate is fixed, $de = 0$, and a weighted average of the money stocks $m^w = \alpha m + (1 - \alpha) m^*$ is held fixed);
(d) modified McKinnon rule ($de = 0$, m^w is allowed to change).

We now turn to the fiscal policy multipliers.

(a) Floating exchange rate

The system (1)–(4) is differentiated and solved. The multipliers for fiscal and monetary policy are:

$$dq = \frac{\lambda}{2[1 - \gamma + \sigma\phi/\beta]}(dg + dg^*) + \frac{1 - \gamma + 2\sigma\phi/\beta}{2\phi[1 - \gamma + \sigma\phi/\beta]}dm - \frac{1 - \gamma}{2\phi[1 - \gamma + \sigma\phi/\beta]}dm^*$$

$$dq^* = \frac{\lambda}{2[1 - \gamma + \sigma\phi/\beta]}(dg + dg^*)$$

$$- \frac{1 - \gamma}{2\phi[1 - \gamma + \sigma\phi/\beta]} dm + \frac{1 - \gamma + 2\sigma\phi/\beta}{2\phi[1 - \gamma + \sigma\phi/\beta]} dm^*$$

$$de = \frac{\lambda}{2\delta}(dg^* - dg) - \frac{1 - \gamma}{2\delta\phi}(dm^* - dm)$$

In this symmetric case fiscal policy is positively transmitted across countries (given that $\gamma < 1$) with the country having the largest fiscal expansion experiencing an appreciation of its currency. Monetary policy is negatively transmitted, since a money supply expansion at home causes the exchange rate to depreciate, and thereby shifts demand from the foreign country to the home market.

(b) Dollar standard

The system is again solved, this time using the assumptions that $de = 0$, dm exogenous and dm^* endogenous. In this case we find:

$$dq = \frac{\lambda}{\Delta}(dg + \gamma\, dg^*) + \frac{\sigma(1 + \gamma)/\beta}{\Delta} dm$$

$$dq^* = \frac{\lambda[\gamma - \sigma\phi/\beta]}{\Delta} dg + \frac{\lambda\,[1 + \phi\sigma/\beta]}{\Delta} dg^* + \frac{\sigma(1 + \gamma)/\beta}{\Delta} dm$$

$$dm^* = \frac{\phi\lambda[\gamma - \sigma\phi/\beta - 1]}{\Delta} dg + \frac{\phi\lambda[1 - \gamma + \phi\sigma/\beta]}{\Delta} dg^* + dm$$

where

$$\Delta = [1 - \gamma^2 + (\phi/\beta)(1 + \gamma)\,] > 0$$

A foreign fiscal expansion is again transmitted positively to the home country, while a domestic fiscal expansion will actually be negatively transmitted if $\sigma\phi > \beta\gamma$. This surprising result occurs because the fiscal expansion by the home country tends to appreciate the currency. The foreign country is thereby required to undertake a monetary contraction in order to prevent its currency from depreciating. The contractionary effects of this endogenous monetary response can be sufficient to offset the normal expansionary effect coming through a rise in exports to the home country. Note that a rise in home-country money, $dm > 0$, raises output in both countries and induces a corresponding increase in the foreign money supply.

There is admittedly something artificial in the way we study this case, in that g and g^* are assumed to be exogenous, so that m^* is the "automatic" instrument that the foreign country uses to peg the exchange rate. If, for example, we were instead to assume that g^* is altered to keep $de = 0$, then a home fiscal expansion ($dg > 0$) would necessarily raise foreign output. In the later empirical sections, the foreign country chooses the combination of dg^* and dm^* optimally in

order to maximize a social welfare function, subject to the constraint that $de = 0$.

(c) McKinnon rule

In the fixed exchange rate regime proposed by McKinnon (1984), the exchange rate between the major countries would be fixed, together with an exogenously set growth rate of a weighted average world money stock. The implications of this regime for fiscal policy in this simple model can be found by setting $dm^w = \alpha dm + (1-\alpha)dm^*$ as an exogenous variable, and requiring that $de = dm^w = 0$. Monetary policy in both countries is endogenous. Doing this we find:

$$dq = \frac{\lambda}{\theta} dg + \frac{\lambda\,[\gamma\beta/\phi(1-\alpha) - \sigma]}{\theta\,[\sigma + \beta/\phi(1-\alpha)]} dg^*$$

$$dq^* = \frac{\lambda}{\theta^*} dg^* + \frac{\lambda\,[\gamma\beta/\phi\alpha - \sigma]}{\theta\,[\sigma + \beta/\phi\alpha]} dg$$

where

$$\theta = 1 - \gamma^2 + \frac{(1+\gamma)\sigma[\gamma + \alpha/(1-\alpha)]}{[\sigma + \beta/\phi(1-\alpha)]}$$

$$\theta^* = 1 - \gamma^2 + \frac{(1+\gamma)\sigma[\gamma + (1-\alpha)/\alpha]}{[\sigma + \beta/\phi\alpha]}$$

In this case both home and foreign fiscal policies will be negatively transmitted if $\sigma\phi(1-\alpha) > \gamma\beta$ for a foreign expansion and $\sigma\phi\alpha > \gamma\beta$ for a domestic expansion.

The form of the monetary regime has been shown to have important implications for the transmission of fiscal policy in the world economy. Later, we will see that the nature of the transmission will have important consequences for policy coordination among the major economies. In the next section we use a large-scale simulation model in an attempt to better quantify the fiscal policy multipliers.

3.3 Fiscal policy in an Empirical Model

In this section we use the MSG (McKibbin-Sachs Global) simulation model to examine the international transmission of fiscal policy. The MSG model was developed in Sachs and McKibbin (1985). The reader is also referred to recent papers by Ishii, McKibbin, and Sachs (1985), McKibbin and Sachs (1985) and Sachs (1985a) for several applications and refinements. The model is a rational-expectations, dynamic general equilibrium macroeconomic model of the world economy. A full list of equations is provided in the Appendix. The world economy is divided into five regions consisting of the United States, Japan, the ROECD, the Organization of Petroleum Exporting Countries (OPEC), and the

non-oil developing countries. Each region is linked via flows of goods and assets. Stock-flow relationships and intertemporal budget constraints are carefully observed. Budget deficits cumulate into a stock of government debt which must eventually be financed, while current account deficits cumulate into a stock of foreign debt. Asset markets are forward-looking, so that the exchange rate and long-term interest rate are conditioned by the entire future path of policy.

There are equations for the internal macroeconomic structure of the three industrialized regions of the United States, the ROECD, and Japan, while the OPEC and developing-country regions have only their foreign trade and financial structures incorporated. Each region produces a good that is an imperfect substitute in the consumption baskets of each of the other regions. Consumption of each good therefore depends on income and relative prices. Private absorption depends on financial wealth, disposable income, and long-term and short-term real interest rates along conventional lines. Nominal wages are predetermined in each period, with the nominal wage change between periods a function of lagged consumer price inflation, the output gap, and the change in the output gap. With the assumption that the gross domestic product (GDP) deflator is a fixed markup over wages, we derive a standard Phillips curve equation. In essence, the model is a generalized version of the Dornbusch (1976) model, in which the goods markets clear less rapidly than the asset markets.

Residents in different countries hold their own country's assets as well as foreign assets (except foreign money), based on the relative expected rates of return, with expectations being formed rationally. While we specify the asset demand functions in a general portfolio balance fashion, the parameter values that we impose make the model behave almost as if assets were perfect substitutes. Money demand is specified according to a standard transactions-demand formulation.

The model is parameterized using actual 1983 trade shares and asset stocks. Behavioral parameters are chosen to be consistent with values found in the empirical literature. We have shown elsewhere (see Sachs 1985a) that the model is able to explain much of the macroeconomic experience of the 1980s, including the strong dollar and trade imbalances by shifts in macroeconomic policies in the United States, Japan, and the ROECD.

We simulate nonlinear and linear versions of the model using numerical techniques which take into account the forward-looking variables in the model. Specifically we use a procedure described by Fair and Taylor (1983). The linearized version of the model is amenable to policy-optimization exercises and has previously been used to consider the gains to policy coordination using dynamic game theory techniques (see Sachs and McKibbin 1985). Throughout the paper we use the linearized version of the model because of the reliance on dynamic

programming in later sections. We have verified in earlier work that there is little difference between the policy multipliers in the linearized and nonlinear versions of the model in the exercises studied here.

We simulate a fiscal expansion by assuming a permanent 1% of GNP increase in real government expenditure on domestic goods, commencing in 1984, which is financed by government debt. We assume that the expenditure increase is permanent, and expected on impact to be permanent, with the budget deficit remaining 1% of GNP above the baseline path. Because of rising interest payments on the accumulating public debt, the deficit would tend to grow over time in the absence of compensating cuts in expenditure or increases in taxes. We assume that over time the increase in interest repayments is paid for through higher tax revenues. Note that the economies all possess a steady state growth rate of 3% per annum. In steady-state equilibrium, a constant deficit is compatible with a fixed debt–GDP ratio as long as the increase in debt due to the deficit causes the total debt stock to grow at the 3% annual rate. This requirement means that the steady-state debt–GDP ratio equals the steady-state deficit–GDP ratio divided by 0.03. For example, a permanent increase in the budget deficit, which raises the deficit from zero to 1% of GDP, causes the steady-state debt–GDP ratio to rise from zero to 33% of GDP.

Table 3.1 contains the results for a fiscal expansion in the United States under a pure floating exchange rate. Real GNP, the exchange rate, and money supply are recorded as a percentage deviation from the initial baseline, while the trade deficit and budget deficit are both reported as deviations from the baseline in percent of potential GNP. Inflation and the nominal interest rate are shown as percentage point deviations from the baseline (indicate with D). The absence of Ricardian consumers and the presence of price stickiness is obvious in the results. The real output multiplier follows a familiar hump shape: output rises initially, but over time rising interest rates, rising prices, a strong dollar, and rising taxes to finance the growing debt burden crowd out the fiscal stimulus. Crowding out is complete by 1989. Note that the dollar appreciates on impact by 3.3% against the Ecu (the currency of the ROECD) and the yen. Interest rates rise throughout the world, although by more in the United States than abroad. The differential in large part captures the expectation of a future depreciation of the U.S. dollar (remember, though, that because of the portfolio balance assumptions, there is also a slight and growing risk premium on dollar-denominated assets). The fiscal impulse is positively transmitted to the rest of the world as Japanese and ROECD trade balances improve, thanks both to the demand stimulus from higher U.S. output and to the strong dollar. The positive transmission quickly fades as rising world interest rates have their effect. Note that inflation initially falls in the United States. This result follows from our somewhat artificial assumption that home

Table 3.1 U.S. Fiscal Expansion under a Flexible Exchange Rate

		1984	1985	1986	1987	1988	1989
U.S. economy							
Real GNP	%	0.9	0.9	0.6	0.4	0.1	−0.1
Inflation	D	−0.2	0.2	0.3	0.4	0.4	0.4
Nominal interest rate	D	0.8	1.1	1.4	1.7	2.0	2.2
Exchange rate (Ecu/$)	%	3.3	3.2	3.4	3.4	3.3	3.2
Trade balance	%GNP	−0.4	−0.4	−0.4	−0.4	−0.4	−0.4
Budget deficit	%GNP	1.0	1.0	1.0	1.0	1.0	1.0
Money supply	%	0.0	0.0	0.0	0.0	0.0	0.0
Japanese economy							
Real GNP	%	0.6	0.2	0.1	−0.1	−0.2	−0.2
Inflation	D	0.2	0.4	0.3	0.3	0.3	0.2
Nominal interest rate	D	0.6	1.1	1.2	1.5	1.6	1.7
Exchange rate (yen/$)	%	3.3	3.1	3.2	3.2	3.1	2.9
Trade balance	%GNP	0.3	0.2	0.2	0.2	0.2	0.2
Budget deficit	%GNP	0.0	0.0	0.0	0.0	0.0	0.0
Money supply	%	0.0	0.0	0.0	0.0	0.0	0.0
ROECD economies							
Real GNP	%	0.8	0.1	0.0	−0.2	−0.3	−0.4
Inflation	D	0.2	0.5	0.3	0.3	0.2	0.2
Nominal interest rate	D	0.7	1.2	1.3	1.5	1.6	1.6
Trade balance	%GNP	0.3	0.3	0.3	0.3	0.3	0.3
Budget deficit	%GNP	0.0	0.0	0.0	0.0	0.0	0.0
Money supply	%	0.0	0.0	0.0	0.0	0.0	0.0

goods prices do not respond at all within the first year to higher domestic output, while import prices fall in response to the appreciation of the dollar.

Table 3.2 contains corresponding results for an ROECD fiscal expansion under a flexible exchange rate. The results are similar to those for the U.S. fiscal stimulus, with a positive transmission of output to the United States and Japan. The ROECD exchange rate appreciates against the dollar by 3.4% on impact, and against the yen by 3.1% on impact.

The results for a U.S. fiscal expansion under a dollar standard regime are shown next in table 3.3. In specifying this regime, we make several crucial assumptions. First, the comparative dynamic exercises assume that the non-U.S. economies peg their exchange rates to the dollar via monetary rather than fiscal policy. In other words, the U.S. fiscal multipliers assume that foreign fiscal policies are held fixed, while foreign monetary policies are wholly endogenous. Second, the form of monetary intervention must be made clear. The authorities could choose to stabilize the exchange rate with intervention on the foreign exchange markets or via intervention in the domestic credit markets (e.g., open-market operations, rediscounting, etc.). In a world of perfect capital

Table 3.2 ROECD Fiscal Expansion under a Flexible Exchange Rate

		1984	1985	1986	1987	1988	1989
U.S. economy							
Real GNP	%	0.7	0.2	0.1	−0.2	−0.3	−0.5
Inflation	D	0.2	0.4	0.4	0.4	0.3	0.2
Nominal interest rate	D	0.6	1.2	1.4	1.6	1.7	1.7
Exchange rate (Ecu/$)	%	−3.4	−3.1	−3.1	−2.9	−2.6	−2.3
Trade balance	%GNP	0.3	0.3	0.3	0.3	0.3	0.3
Budget deficit	%GNP	0.0	0.0	0.0	0.0	0.0	0.0
Money supply	%	0.0	0.0	0.0	0.0	0.0	0.0
Japanese economy							
Real GNP	%	0.5	0.1	0.1	−0.1	−0.2	−0.4
Inflation	D	0.2	0.4	0.3	0.3	0.2	0.1
Nominal interest rate	D	0.4	1.0	1.2	1.4	1.4	1.4
Exchange rate (yen/$)	%	−0.3	−0.4	−0.5	−0.6	−0.7	−0.8
Trade balance	%GNP	0.3	0.3	0.3	0.2	0.2	0.1
Budget deficit	%GNP	0.0	0.0	0.0	0.0	0.0	0.0
Money supply	%	0.0	0.0	0.0	0.0	0.0	0.0
ROECD economies							
Real GNP	%	1.1	1.1	0.7	0.4	0.0	−0.4
Inflation	D	−0.2	0.3	0.5	0.6	0.5	0.5
Nominal interest rate	D	0.9	1.4	2.0	2.4	2.6	2.8
Trade balance	%GNP	−0.4	−0.3	−0.3	−0.3	−0.3	−0.3
Budget deficit	%GNP	1.0	1.0	1.0	1.0	1.0	1.0
Money supply	%	0.0	0.0	0.0	0.0	0.0	0.0

mobility, all of these alternatives would be identical from the point of view of macroeconomic outcomes, while in a world of imperfect capital mobility, differences will arise depending on the nature of exchange rate pegging. Since our model assumes very high, though not fully perfect, substitutability, the choice of intervention mechanism is quantitatively of some, but only minor, importance. In fact, in all of our specifications used in the paper, we assume that the exchange rate is stabilized through interventions in the domestic money market.

Several results are striking. The first is the negative transmission of the U.S. fiscal expansion to the rest of the world. In this case both Japan and the ROECD adopt severely contractionary monetary policies in order to maintain the fixed exchange rate. The result is severe recession in both regions. The recessionary effect of the contractionary monetary policies quickly feeds back to the United States, and does much to dampen the U.S. fiscal multiplier (it turns negative by 1987). The asymmetry in the dollar standard regime is illustrated in table 3.4, which shows the results for an ROECD fiscal expansion. In contrast to the U.S. fiscal expansion, the ROECD fiscal expansion is positively transmitted to the rest of the world. The Ecu tends to appreciate, so that the ROECD monetary authorities are compelled to expand the

Table 3.3 U.S. Fiscal Expansion under a Dollar Standard

		1984	1985	1986	1987	1988	1989
U.S. economy							
Real GNP	%	1.7	0.6	0.1	−0.4	−0.5	−0.3
Inflation	D	0.0	0.6	0.3	0.1	−0.2	−0.4
Nominal interest rate	D	1.4	2.0	1.8	1.4	0.9	0.4
Exchange rate (Ecu/$)	%	0.0	0.0	0.0	0.0	0.0	0.0
Trade balance	%GNP	−0.3	−0.4	−0.6	−0.7	−0.8	−0.8
Budget deficit	%GNP	1.0	1.0	1.0	1.0	1.0	1.0
Money supply	%	0.0	0.0	0.0	0.0	0.0	0.0
Japanese economy							
Real GNP	%	−1.0	−1.6	−1.6	−1.4	−0.8	0.0
Inflation	D	0.0	−0.5	−0.9	−1.2	−1.4	−1.3
Nominal interest rate	D	1.4	1.9	1.7	1.3	0.8	0.2
Exchange rate (yen/$)	%	0.0	0.0	0.0	0.0	0.0	0.0
Trade balance	%GNP	0.1	0.1	0.1	0.1	0.2	0.3
Budget deficit	%GNP	0.0	0.0	0.0	0.0	0.0	0.0
Money supply	%	−1.0	−2.5	−3.8	−4.9	−5.8	−6.4
ROECD economies							
Real GNP	%	−2.1	−3.2	−2.7	−1.6	0.2	2.4
Inflation	D	0.0	−0.8	−1.5	−1.9	−1.9	−1.4
Nominal interest rate	D	1.4	1.9	1.7	1.2	0.5	0.0
Trade balance	%GNP	0.2	0.4	0.5	0.6	0.6	0.5
Budget deficit	%GNP	0.0	0.0	0.0	0.0	0.0	0.0
Money supply	%	−1.4	−3.6	−5.7	−7.2	−8.0	−7.8

domestic money supply. This leads to an enormous expansion in the ROECD and positive transmission to the other economies.

Table 3.5 illustrates the consequence of a fiscal expansion under the McKinnon rule. In this case we study the effects of a fiscal expansion under the assumption that a geometric weighted average of the money supplies in the United States, the ROECD, and Japan is fixed, and that the exchange rates are similarly fixed. The weights used (somewhat arbitrarily) are the GNP weights for 1983. In this case, as with the U.S. expansion under the dollar standard, the transmission of fiscal policy is negative. Once again, the non-U.S. economies are compelled to contract their money stocks while the United States expands its money stock. The result is a rise in interest rates abroad that is sufficient to overwhelm the direct effects of the U.S. stimulus. The extent of the recession abroad is less than in the dollar standard, since, in the McKinnon case, the United States is compelled to expand its money supply in line with the fiscal expansion.

The effects of an ROECD fiscal expansion under the McKinnon rule are shown in table 3.6. Now the ROECD fiscal expansion is negatively transmitted to the rest of the world. Clearly, the McKinnon rule on world money supplies imposes more symmetry than does the dollar

Table 3.4 ROECD Fiscal Expansion under a Dollar Standard

		1984	1985	1986	1987	1988	1989
U.S. economy							
Real GNP	%	0.1	0.5	0.6	0.5	0.1	−0.5
Inflation	D	0.0	0.2	0.5	0.7	0.9	0.8
Nominal interest rate	D	0.1	0.6	1.3	2.2	3.0	3.4
Exchange rate (Ecu/$)	%	0.0	0.0	0.0	0.0	0.0	0.0
Trade balance	%GNP	0.3	0.4	0.6	0.7	0.7	0.6
Budget deficit	%GNP	0.0	0.0	0.0	0.0	0.0	0.0
Money supply	%	0.0	0.0	0.0	0.0	0.0	0.0
Japanese economy							
Real GNP	%	0.6	0.9	0.8	0.6	0.1	−0.5
Inflation	D	0.1	0.4	0.7	1.0	1.1	0.9
Nominal interest rate	D	0.1	0.5	1.2	2.0	2.7	3.0
Exchange rate (yen/$)	%	0.0	0.0	0.0	0.0	0.0	0.0
Trade balance	%GNP	0.2	0.4	0.5	0.5	0.5	0.3
Budget deficit	%GNP	0.0	0.0	0.0	0.0	0.0	0.0
Money supply	%	0.2	0.6	0.9	1.2	1.4	1.6
ROECD economies							
Real GNP	%	4.7	4.5	3.2	1.1	−1.6	−4.3
Inflation	D	0.1	1.8	2.6	2.8	2.4	1.5
Nominal interest rate	D	0.1	0.8	1.7	2.8	3.8	4.4
Trade balance	%GNP	−0.3	−0.4	−0.5	−0.6	−0.6	−0.6
Budget deficit	%GNP	1.0	1.0	1.0	1.0	1.0	1.0
Money supply	%	1.7	4.2	6.2	7.5	7.8	7.0

rule. In the case of an ROECD fiscal expansion under the McKinnon rule, the United States and Japan contract monetary policy and the ROECD expands monetary policy in order to maintain the fixed exchange rate. The consequence of the contractionary monetary policies is to cause a recession in Japan and the United States.

3.4 Implications of the Exchange Regime for Strategic Interactions of Monetary and Fiscal Policy

As we noted in the beginning, one of the most attractive aspects of monetary reform is the possibility of reducing the inefficient strategic behavior of national macroeconomic authorities. It is well known that if policymakers in the United States, the ROECD, and Japan independently select their monetary and fiscal policies, taking as given the actions of the other countries, the resulting (Nash) equilibrium of macroeconomic policies is likely to be inefficient, in the sense that another vector of policy parameters could simultaneously raise the level of social welfare in all of the countries. In this brief theoretical section, we illustrate how a change of regime might make the independent actions of national policymakers more efficient.

Table 3.5 U.S. Fiscal Expansion under the McKinnon Rule

		1984	1985	1986	1987	1988	1989
U.S. economy							
Real GNP	%	2.3	1.9	1.4	0.7	0.0	−0.8
Inflation	D	0.0	0.9	1.1	1.1	1.0	0.8
Nominal interest rate	D	0.6	1.0	1.3	1.5	1.7	1.9
Exchange rate (Ecu/$)	%	0.0	0.0	0.0	0.0	0.0	0.0
Trade balance	%GNP	−0.2	−0.3	−0.4	−0.6	−0.7	−0.7
Budget deficit	%GNP	1.0	1.0	1.0	1.0	1.0	1.0
Money supply	%	0.6	1.5	2.4	3.1	3.6	3.8
Japanese economy							
Real GNP	%	−0.2	−0.4	−0.4	−0.3	−0.2	−0.1
Inflation	D	0.0	0.0	−0.1	−0.2	−0.2	−0.2
Nominal interest rate	D	0.6	1.0	1.2	1.4	1.5	1.6
Exchange rate (yen/$)	%	0.0	0.0	0.0	0.0	0.0	0.0
Trade balance	%GNP	0.1	0.2	0.2	0.2	0.3	0.3
Budget deficit	%GNP	0.0	0.0	0.0	0.0	0.0	0.0
Money supply	%	−0.4	−0.8	−1.3	−1.7	−2.1	−2.3
ROECD economies							
Real GNP	%	−0.5	−0.9	−0.7	−0.5	−0.1	0.4
Inflation	D	0.0	−0.2	−0.3	−0.4	−0.3	−0.2
Nominal interest rate	D	0.6	1.0	1.2	1.4	1.5	1.5
Trade balance	%GNP	0.2	0.3	0.4	0.4	0.5	0.5
Budget deficit	%GNP	0.0	0.0	0.0	0.0	0.0	0.0
Money supply	%	−0.5	−1.2	−1.9	−2.5	−2.9	−3.0

Consider a hypothetical situation in which two symmetric countries choose monetary and fiscal policies to maximize a social welfare function in output, in the fiscal deficit, and in the level of prices (in the dynamic model, the target will be the inflation rate). For simplicity, we assume that the welfare functions are identical and of the following quadratic form:

$$(5) \qquad W = -(q^2 + \mu\, p_c^{\,2} + \nu\, g^2),$$

where p_c is the (log) level of consumer prices (the foreign welfare function is of course a function of the corresponding foreign variables). The bliss points for each country are zero levels of (log) output, consumer prices, and fiscal expenditure. We use the earlier static model of section 3.2, with the addition that consumer prices in each country are a weighted average of home prices and import prices (valued in domestic currency):

$$p_c = \eta\, p + (1 - \eta)\,(p^* + e)$$

$$p_c^* = \eta\, p^* + (1 - \eta)\,(p - e)$$

Table 3.6 **ROECD Fiscal Expansion under the McKinnon Rule**

		1984	1985	1986	1987	1988	1989
U.S. economy							
Real GNP	%	−0.6	−0.8	−0.6	−0.3	0.0	0.4
Inflation	D	0.0	−0.1	−0.2	−0.2	−0.2	−0.1
Nominal interest rate	D	0.9	1.5	1.8	2.0	2.0	1.9
Exchange rate (Ecu/$)	%	0.0	0.0	0.0	0.0	0.0	0.0
Trade balance	%GNP	0.2	0.3	0.4	0.5	0.6	0.5
Budget deficit	%GNP	0.0	0.0	0.0	0.0	0.0	0.0
Money supply	%	−0.6	−1.5	−2.2	−2.7	−2.9	−2.8
Japanese economy							
Real GNP	%	−0.2	−0.4	−0.3	−0.2	−0.1	0.0
Inflation	D	0.1	0.0	0.0	0.0	0.0	0.0
Nominal interest rate	D	0.9	1.4	1.7	1.8	1.8	1.6
Exchange rate (yen/$)	%	0.0	0.0	0.0	0.0	0.0	0.0
Trade balance	%GNP	0.2	0.3	0.4	0.4	0.4	0.3
Budget deficit	%GNP	0.0	0.0	0.0	0.0	0.0	0.0
Money supply	%	−0.5	−1.0	−1.5	−1.7	−1.8	−1.7
ROECD economies							
Real GNP	%	3.1	2.3	1.5	0.4	−0.8	−1.8
Inflation	D	0.0	1.2	1.4	1.4	1.1	0.7
Nominal interest rate	D	0.9	1.6	2.1	2.5	2.7	2.8
Trade balance	%GNP	−0.2	−0.3	−0.4	−0.5	−0.6	−0.6
Budget deficit	%GNP	1.0	1.0	1.0	1.0	1.0	1.0
Money supply	%	0.8	1.8	2.7	3.3	3.5	3.4

Maintaining the assumption that domestic and foreign output prices are fixed, with $p = p^* = p_0 > 0$, we see that fluctuation in the exchange rate is the only factor that can cause p_c and p_c^* to change in the short run.

In the case of symmetric countries, it will necessarily be the case that the exchange rate equals zero ($e = 0$). Given this fact, consumer prices in each country are fixed at the level p_0. Since p_c cannot be reduced in both countries simultaneously, the best symmetric solution is merely to live with the fact that p_c is above the bliss level, and then to set $g = g^* = 0$, and $m = m^* = p_0$, so that output is kept at $q = q^* = 0$. In other words, the economies should sit at "full employment" and zero budget deficit, suffering the inevitable fact that consumer prices are above their bliss level.

Unfortunately, in noncooperative policymaking under floating exchange rates, this efficient equilibrium will not be reached. Each country's policy authorities will believe that a strong currency option is available that will allow them to reduce p_c, and therefore to import price stability (and to export inflation!). Each country will therefore

aim its monetary policy in a contractionary direction and its fiscal policy in an expansionary direction in order to exploit the possible anti-inflationary gains of a strong currency. Of course, this noncooperative outcome has all the trappings of a prisoners' dilemma game, in that the two symmetric countries will be unable, simultaneously, to enjoy a strong currency vis-à-vis each other! The results of the noncooperative game will therefore be (1) a policy mix geared toward fiscal expansion cum monetary contraction, with a socially undesirable level of fiscal deficits; (2) overly contractionary policies in total, with output reduced below the efficient symmetric level of $q = q^* = 0$; and (3) an exchange rate $e = 0$, with $p_c = p_c^* = p_0$, i.e., no success in either country of manipulating the exchange rate to its own advantage.

These results are easy to confirm algebraically. The home country maximizes the social welfare function (eq. 5) with respect to m and g, taking as given the level of m^* and g^*. The foreign country makes the comparable policy analysis, arriving at values of m^* and g^*, taking as given m and g. At the Nash equilibrium in this symmetric case, $m = m^*$ and $g = g^*$, with the specific values of the target variables given as follows (note that the multipliers dy/dx in the equations are as given in the derivations in section 3.2):

$$q = q^* = -[\mu\, p_0\,(1 - \eta)(de/dm)]/(dq/dm) < 0$$

$$p_c = p_c^* = p_0 > 0$$

$$g = g^* = -[q\,(dq/dg) + \mu\, p\,(1 - \eta)(de/dg)]/v > 0$$

Remember that $de/dm > 0$, $de/dg < 0$, $dq/dm > 0$, $dq/dg > 0$, in order to derive the signs of the preceding expressions. Thus, output is below zero, while government spending is above zero. By simple substitution, it is easy to see that $m = m^* < p_0$. In sum we have established the early conclusions: m is too tight and g is too loose relative to the efficient equilibrium, and aggregate demand overall is too tight (since $q = q^* < 0$).

It is important to note that the inefficiency in this game would hold if the players had only one instrument, either m or g, instead of two. If m and m^* were fixed, with the authorities setting g and g^*, there would still be a bias toward inefficiently large fiscal deficits, whereas if g and g^* are fixed while the game is played with m and m^*, then the bias is toward overcontractionary policies. In both cases, the countries attempt to manipulate the exchange rate in their favor (i.e., toward an appreciation).

Now, consider how this game would be played under the McKinnon standard. In that case, policymakers choose only g and g^*, since monetary policy is set according to the two rules that m^w is fixed and that the exchange rate is fixed (in this case at $e = 0$). The cooperative optimum equilibrium is again the same, with $q = q^* = 0, g = g^* = 0,$

and $p_c = p_c^* = p_0$. To achieve this equilibrium, m^w should be set at p_0, and fiscal policy in both countries should be set at zero.

Assume now that the McKinnon rule is in place, but with each fiscal policy authority free to choose the level of fiscal spending in a noncooperative way. Suppose also that m^w is fixed exogenously at p_0 (more on this assumption in a moment). It now turns out that the independent actions of the fiscal authorities will lead to the social optimum. The policymaker has no incentive to try to deviate from the point of zero fiscal expenditure. Higher fiscal spending no longer improves the price performance, as it did under the floating system, since now the exchange rate is fixed at zero. Therefore fiscal expenditure merely worsens the budget deficit without any compensating benefits. These results are verified formally by maximizing the social welfare function at home with respect to g, and abroad with respect to g^*. It is easy to verify that $g = g^* = 0$ constitutes a Nash equilibrium.

To see this formally, we simply differentiate the utility function with respect to g, and set the results equal to zero. Under the McKinnon rule, $de/dg = 0$, so that the result of differentiation is: $dW/dg = 0 = -[q(dq/dg) + vg]$. With m^w at p_0, and $g^* = 0$, this first-order condition is satisfied at $q = 0$ and $g = 0$. The same result holds for the foreign country when $g = 0$, so that the pair $g = g^* = 0$ constitutes a Nash equilibrium.

Thus, we have a case in which a change in monetary regime eliminates the inefficient strategic interactions of the two governments. The essential inefficiency of the game under floating exchange rates resulted from the fact that the two sides had inconsistent exchange rate targets, which obviously could not be simultaneously satisfied. Under the McKinnon rule, neither player attempts or is able to influence the exchange rate in his favor. It must be stressed that the efficiency of the McKinnon solution relied heavily on two facts. First, it was assumed that the world money stock m^w was at the global optimum. In fact, McKinnon has opted for a fixed level of m^w in most discussions of his proposal, and there is no reason to believe that the selected value of m^w would necessarily be at an efficient level. Second, the symmetry of the model and the symmetry of the "shock" (both countries had prices equally above the optimum) meant that the exchange rate did not have to adjust in order to adapt efficiently to the shock. In later sections we will study asymmetric cases, in which efficiency requires a change in the nominal exchange rate.

3.5 Strategic Interactions under Alternative Regimes in the MSG Model

We now employ the large-scale simulation model to study strategic interactions in the dynamic case. For this purpose we use two meth-

odologies. In the first, we place the countries in a particular historical situation and study the optimal strategies of each country over time. A benchmark "cooperative" equilibrium is used as a benchmark with which to compare the performance in the alternative monetary regimes. In the second and more novel approach, introduced in section 3.6, we study the asymptotic properties of the system under alternative exchange arrangements. In that case we assume that the system is buffeted through time by various stochastic disturbances, in output markets, money markets, and elsewhere. Using a technique described in that section, we can calculate the steady-state variance/covariance structure of the target variables in each exchange regime, and thereby measure the average operating properties of each system. In general, the MSG model is particularly well suited to this kind of analysis, since the model is easily reducible to a first-order difference equation system, which is easy to analyze using standard techniques of dynamic analysis.

To study the dynamic games involved in setting national policy, we specify a social welfare function for each of the three OECD regions. Social welfare in each region is specified as a function of various macroeconomic targets, such as the inflation rates, the GDP gap, the current account deficit, and the budget deficit. The intertemporal social welfare functions are written as additively separable quadratic functions of the targets in each period. The specific form that we employ makes social welfare a function of the output gap Q, consumer price index inflation π, the current account deficit as a percent of GDP, denoted CA, and the level of the budget deficit relative to GDP, denoted D. The specific function that we employ is as follows:

$$W = -\sum_{t=0}^{\infty} \delta^t [0.5\ Q_t^2 + \pi_t^2 + 0.5\ CA_t^2 + 0.6\ D_t^2] \tag{6}$$

δ is the social rate-of-time discount. Clearly, macroeconomic bliss is achieved when the GDP gap is zero, CPI inflation is zero, the current account is in balance, and the budget is in balance.

Corresponding welfare functions are assumed for the ROECD and Japan. A couple of preliminary comments should be made about this welfare function. First, the results are obviously specific to a given numerical specification. The inefficiency of a strategic noncooperative interaction will depend quantitatively on the weights attached to the countries' target variables. In the simple example of the section 3.4, for example, the inefficiency resulted from the fact that both countries were attempting simultaneously to reduce their price levels via exchange rate appreciation. The inefficiency of the noncooperative solution in that case depends crucially on the relative weight placed by the countries on the inflation target. For purposes of study of our large-scale model, we have not yet determined any way to study the dynamic

games except through the specification of particular loss functions. The second point is that the loss function relates to macroeconomic targets (inflation, unemployment, etc.) rather than to more basic categories of real consumption over time. Our model does not have strong enough microeconomic foundations at this point to write policy targets in terms of the "primitives" of consumption expenditure, as might be desirable in a more sophisticated treatment.

Using results of dynamic game theory, we calculate (with numerical dynamic programming methods) a set of fiscal policy rules in the three OECD regions that have the following equilibrium property: the rules for each country are optimal for the given country (in that they maximize the dynamic social welfare function), taking as given the rules that are being employed in the other regions. A more rigorous statement of the equilibrium conditions and a discussion of the solution technique is given in Oudiz and Sachs (1985). The optimum we calculate is time consistent. That is, there is no incentive to choose a different set of policies if the optimization problem is solved again at some point in the future. The policies are therefore also credible to the forward-looking private agents and other countries in the model. We have shown elsewhere (see Sachs and McKibbin 1985), that, as in the static model of the section 3.4, such an equilibrium does not necessarily yield very attractive outcomes. These rules will likely contain some types of beggar-thy-neighbor policies and will therefore show some of the disadvantages of the classic prisoners' dilemma. For example, in the case where both monetary and fiscal policies are chosen according to such rules under a flexible exchange rate regime, we will see that the equilibrium rules are likely to produce excessive budget deficits and high real interest rates in an inflationary environment, just as we found for the static model.

It is therefore very likely that the social welfare of all of the countries can be enhanced by a different set of policies, chosen cooperatively. We can find such a set new rules by assuming that a single "world" planner maximizes a single social welfare function, which is a weighted average of the social welfare functions of the United States, Japan, and the ROECD, where the weights are GNP shares. The result of this global optimization is a new set of rules that avoids prisoners' dilemmas. These optimal "cooperative" rules can then be compared with the "noncooperative" rules found in the first stage. In general, it will be the case that "cooperative" policies result in some form of managed float, in that global efficiency of policy setting will almost surely require changes in the nominal exchange rates of the three countries in the course of macroeconomic adjustment.

We use this technique to generate noncooperative rules for fiscal policy, given the monetary regime in place, as well as a set of coop-

erative rules. In the case of the flexible exchange rate regime, we assume that policymakers choose *both* monetary and fiscal policies to reach targets for output, inflation, the current account, and budget deficits. In the dollar standard case the United States is allowed to optimize on both monetary and fiscal policies, whereas Japan and the ROECD are only given the option of choosing fiscal policy. Their money supplies are made endogenous and are set at the levels necessary to keep the exchange rate unchanged, given the levels of the state variables of the world economy, and given the levels of their own fiscal policies and of the monetary and fiscal policies in the other economies. In the McKinnon regime, each region chooses fiscal policy to reach its given targets. In the "simple" McKinnon regime, the global money stock is held fixed, while in the "modified" McKinnon regime, the three regions cooperatively set the global money stock, m^w, while they choose their fiscal policies independently. In each case the dynamic welfare function is the one we have just introduced.

A word must be said about how we implement the modified McKinnon regime. Remember that, in that case, the global money stock is set cooperatively, while the individual countries set the fiscal policies noncooperatively. To find a "good" rule for the global money stock, we employed the following iterative procedure. We found the rule for global money that maximizes a global social welfare function (a GNP-weighted average of the individual region social welfare functions) assuming that fiscal policies were also chosen cooperatively. Then, given the resulting rule for global money, we let the individual policymakers choose optimal fiscal policies in a noncooperative manner. Taking as given these resulting rules for fiscal policy, we then recalculated an optimal cooperative rule for global money, and used that one as the rule to control the evolution of m^w. Ideally, the linear rule should be found for m^w that maximizes the global welfare, subject to the constraint that the fiscal rules are chosen uncooperatively by the separate regions. This formulation would make the cooperative monetary authorities Stackelberg leaders with respect to the fiscal authorities of the individual countries. Unfortunately we have not yet been able to implement this more ambitious approach.

As a formal matter, the MSG model can be written in a standard state space representation in the following way:

$$X_{t+1} = AX_t + Be_t + CU_t + Z\epsilon_t \tag{7}$$

$$_t(e_{t+1}) = DX_t + Fe_t + GU_t + W\epsilon_t \tag{8}$$

$$\tau_t = MX_t + Le_t + NU_t + O\epsilon_t \tag{9}$$

where:

X_{t+1} is a vector of state variables (in this case 37×1)
U_t is a vector of control variables
e_t is a vector of nonpredetermined (or "jumping") variables
τ_t is a vector of target variables
ϵ_t is a vector of stochastic shocks (6×1)
${}_t(e_{t+1})$ is the expectation taken at time t of the jumping variables at time $t+1$ based on information available at time t

The model variables are divided into state variables X_t, historically given at any moment; "jumping" or forward-looking variables e_t, which are fixed in order to place the system on the stable dynamic manifold; control variables U_t including fiscal and monetary policies; and stochastic shocks ϵ_t. Assuming that in each period the policy variables must be set before the stochastic shocks are observed, the policy rules are all written in the form:

$$U_t = \Gamma X_t \quad (10)$$

In other words, the general specification of rules links the control variables to the state variables in any period via a fixed set of linear rules. Of course, the linearity results from the assumption of linearity of the underlying model and the assumption of a quadratic social welfare function in each region.

The dynamic game that we study in this section has the policy authorities all confronting an unanticipated jump in nominal wage inflation of 10% per year, after being on a baseline path of zero inflation, zero GDP gap, budget balance, and current account balance. The shock hits in 1984, raising domestic prices in the year by 10% and setting in motion several years of high inflation, given the inflationary momentum built into the Phillips curve equation (which makes current nominal wage change a function of lagged nominal price change). In each region, monetary and fiscal policies are deployed in order to engineer an optimal rate of disinflation, subject to the social welfare function (which trades off output, inflation, budget, and current account deficits) and subject to the policy rules taken abroad. In this analysis we assume that the system is nonstochastic (that is, all ϵ are zero), returning to the stochastic case in the section 3.6, when we look at the steady-state operating properties of the alternative regimes.

Table 3.7 illustrates the case of optimal cooperative disinflation. Since all countries begin with a shock of 10% wage inflation, it is optimal to pursue tight macroeconomic policies in order to bring inflation down to zero in the period of a few years. In this case, the nominal money stock growth is kept low and falling, so that real money balances (not shown) fall sharply in the early period of disinflation. Since domestic prices in each of the three regions has risen by 10% in 1984, the fact

Table 3.7 Cooperative Response to an Inflationary Shock under a Flexible Exchange Rate

		1984	1985	1986	1987	1988	1989
U.S. economy							
Real GNP	%	−10.1	−8.0	−6.4	−5.2	−4.1	−3.3
Inflation	D	10.0	5.9	4.8	3.8	3.0	2.4
Nominal interest rate	D	15.4	12.3	9.7	7.6	6.1	5.0
Exchange rate (Ecu/$)	%	0.6	0.0	−0.5	−1.0	−1.4	−1.9
Trade balance	%GNP	0.2	0.2	0.1	0.1	0.1	0.1
Budget deficit	%GNP	−0.5	−0.3	−0.2	−0.1	−0.1	0.0
Money supply	%	−0.8	2.0	6.9	12.2	17.0	21.2
Japanese economy							
Real GNP	%	−9.8	−7.9	−6.4	−5.1	−4.2	−3.4
Inflation	D	9.2	5.4	4.4	3.5	2.9	2.3
Nominal interest rate	D	16.1	12.9	10.0	7.8	6.2	4.9
Exchange rate (yen/$)	%	−5.1	−4.5	−3.9	−3.5	−3.3	−3.1
Trade balance	%GNP	−0.8	−0.6	−0.6	−0.5	−0.4	−0.2
Budget deficit	%GNP	−0.8	−0.5	−0.4	−0.3	−0.3	−0.2
Money supply	%	−1.1	0.8	5.3	10.3	15.0	19.0
ROECD economies							
Real GNP	%	−10.3	−8.0	−6.4	−5.1	−4.0	−3.2
Inflation	D	9.9	5.8	4.6	3.6	2.9	2.3
Nominal interest rate	D	14.8	11.6	8.9	6.8	5.3	4.2
Trade balance	%GNP	0.4	0.2	−0.1	−0.2	−0.3	−0.2
Budget deficit	%GNP	0.0	0.0	0.0	0.0	0.0	−0.1
Money supply	%	−0.5	2.3	7.3	12.6	17.4	21.4

that nominal money stocks are falling in 1984 relative to the baseline means that real money balances are declining by more than 10% in 1984, i.e., that monetary policy is highly nonaccommodative in the year of the price shock. Also, fiscal policy is restrictive in the United States (where there is a surplus of 0.5% of GNP in 1984), and Japan (where there is a surplus of 0.8% of GNP), while fiscal policy is neutral in the ROECD. In all countries there is a sharp recession in 1984 of about 10% of GDP relative to potential, and actual GDP reapproaches its potential level only slowly over time. Note that, because of the monetary stringency, there is a sharp rise in nominal short-term interest rates, with interest rates in 1984 rising by 15.4 percentage points in the United States, by 16.1 percentage points in Japan, and by 14.8 percentage points in the ROECD. Interest rates fall gradually over time, in line with the gradual disinflation.

Table 3.7 shows the optimal cooperative response. Table 3.8 shows what happens when policy makers act independently and noncooperatively, under a regime of floating exchange rates. Suddenly, everybody tries to maintain a strong currency in order to help fight off the infla-

Table 3.8 Noncooperative Response to an Inflationary Shock under a Flexible Exchange Rate

		1984	1985	1986	1987	1988	1989
U.S. economy							
Real GNP	%	−10.2	−8.0	−6.4	−5.2	−4.1	−3.3
Inflation	D	9.9	5.9	4.7	3.8	3.0	2.4
Nominal interest rate	D	19.3	14.7	11.8	9.4	7.7	6.3
Exchange rate (Ecu/$)	%	1.5	0.5	−0.1	−0.7	−1.2	−1.7
Trade balance	%GNP	0.2	0.1	0.1	0.1	0.1	0.1
Budget deficit	%GNP	1.3	0.8	0.6	0.6	0.5	0.4
Money supply	%	−2.5	−0.1	4.9	10.3	15.3	19.6
Japanese economy							
Real GNP	%	−10.1	−7.8	−6.3	−5.1	−4.1	−3.3
Inflation	D	9.1	5.3	4.3	3.5	2.8	2.3
Nominal interest rate	D	19.9	15.6	12.7	10.3	8.6	7.3
Exchange rate (yen/$)	%	−5.2	−4.6	−4.1	−3.7	−3.5	−3.3
Trade balance	%GNP	−0.7	−0.6	−0.5	−0.5	−0.4	−0.3
Budget deficit	%GNP	1.4	0.9	0.7	0.6	0.5	0.5
Money supply	%	−2.9	−1.4	2.8	7.8	12.5	16.6
ROECD economies							
Real GNP	%	−10.3	−8.0	−6.3	−5.0	−4.0	−3.2
Inflation	D	10.0	5.8	4.6	3.7	2.9	2.3
Nominal interest rate	D	18.3	14.0	11.1	8.9	7.2	5.9
Trade balance	%GNP	0.6	0.3	0.0	−0.2	−0.3	−0.3
Budget deficit	%GNP	1.6	1.0	0.8	0.6	0.5	0.5
Money supply	%	−2.1	0.5	5.5	10.9	15.8	19.9

tionary shock. Each country therefore has more expansionary fiscal policy than in the cooperative solution (the United States, for example, runs a budget deficit of 1.3% of GNP in 1984) and has more contractionary monetary policy than in the cooperative case. The result is that noncooperation under floating leads to very high world interest rates, since the whole world is tilted toward fiscal expansion and monetary contraction. U.S. nominal interest rates jump by 19.3 percentage points in the noncooperative floating rate case, whereas they increased by only 14.8 percentage points in the cooperative policy response.

In tables 3.9 and 3.10 we ask what happens when the same shock occurs in a regime of fixed exchange rates, first under a dollar standard and then under a modified McKinnon rule. The notable point about the dollar standard is that the United States still has an incentive to pursue fiscal expansion and monetary contraction, just as under the floating rate case. A fiscal expansion in the United States reduces output abroad (we noted the negative transmission in sections 3.2 and 3.3), and thereby lowers foreign inflation. Lower foreign inflation in turn lowers U.S. import prices. Similarly, a U.S. monetary contraction has the same side-effect.

Table 3.9 Noncooperative Response to an Inflationary Shock under a Dollar Standard

		1984	1985	1986	1987	1988	1989
U.S. economy							
Real GNP	%	−10.5	−8.3	−6.6	−5.2	−4.1	−3.3
Inflation	D	9.9	5.7	4.5	3.5	2.8	2.2
Nominal interest rate	D	22.8	18.1	14.4	11.5	9.3	7.6
Exchange rate (Ecu/$)	%	0.0	0.0	0.0	0.0	0.0	0.0
Trade balance	%GNP	0.2	0.1	0.0	0.0	−0.1	0.0
Budget deficit	%GNP	2.8	2.2	1.9	1.5	1.3	1.1
Money supply	%	−4.2	−2.7	2.0	7.5	12.7	17.1
Japanese economy							
Real GNP	%	−9.8	−7.7	−6.2	−5.0	−4.1	−3.4
Inflation	D	9.7	5.8	4.7	3.7	3.0	2.4
Nominal interest rate	D	22.8	18.2	14.6	11.7	9.6	8.0
Exchange rate (yen/$)	%	0.0	0.0	0.0	0.0	0.0	0.0
Trade balance	%GNP	0.1	0.0	−0.2	−0.3	−0.4	−0.4
Budget deficit	%GNP	1.3	0.9	0.7	0.6	0.6	0.5
Money supply	%	−4.1	−2.5	2.4	7.9	13.1	17.6
ROECD economies							
Real GNP	%	−10.7	−8.1	−6.3	−4.8	−3.8	−2.9
Inflation	D	9.8	5.6	4.5	3.6	2.9	2.4
Nominal interest rate	D	22.8	18.4	15.0	12.3	10.2	8.6
Trade balance	%GNP	0.4	0.2	0.0	−0.2	−0.3	−0.3
Budget deficit	%GNP	4.4	3.2	2.5	1.9	1.4	1.0
Money supply	%	−4.3	−2.9	1.7	7.2	12.4	17.0

Thus, the United States, as center of the monetary system, shifts its policy mix in a direction intended to promote very sharp disinflation abroad. In the other countries, expansionary budget policies are undertaken defensively, in order to limit the extent of disinflation and economic contraction implicit in the U.S. policies. The result is that, like the floating rate case, each country is led to pursue a policy mix of large budget deficits and very contractionary monetary policies. World interest rates shoot up, and the world falls into recession.

Table 3.10, under the modified McKinnon regime, shows the advantage of this regime in fighting a global inflationary shock. As we saw in the theoretical analysis of section 3.4, countries no longer have the incentive to run large budget deficits under the McKinnon regime, since they know that they cannot get disinflationary benefits from such a policy mix. Therefore they all choose to have lower budget deficits than in the noncooperative equilibrium under floating, and than in the noncooperative equilibrium under the dollar standard. In this sense, the shift in regime almost substitutes for the cooperation assumed in table 3.7. World interest rates rise much less under the modified McKinnon plan than under the other noncooperative regimes.

Table 3.10 Noncooperative Response to an Inflationary Shock under the McKinnon Rule

		1984	1985	1986	1987	1988	1989
U.S. economy							
Real GNP	%	−10.0	−8.0	−6.5	−5.2	−4.2	−3.4
Inflation	D	9.9	5.9	4.7	3.7	3.0	2.3
Nominal interest rate	D	16.6	13.3	10.6	8.4	6.8	5.6
Exchange rate (Ecu/$)	%	0.0	0.0	0.0	0.0	0.0	0.0
Trade balance	%GNP	0.1	0.1	0.0	0.0	0.0	0.0
Budget deficit	%GNP	0.2	0.3	0.4	0.4	0.4	0.4
Money supply	%	−1.2	1.2	6.0	11.2	16.0	20.1
Japanese economy							
Real GNP	%	−8.3	−7.0	−6.0	−5.1	−4.4	−3.8
Inflation	D	9.7	6.3	5.2	4.2	3.3	2.6
Nominal interest rate	D	16.6	13.1	10.2	7.9	6.2	5.0
Exchange rate (yen/$)	%	0.0	0.0	0.0	0.0	0.0	0.0
Trade balance	%GNP	−0.1	−0.3	−0.4	−0.5	−0.5	−0.5
Budget deficit	%GNP	−1.3	−1.1	−0.9	−0.7	−0.4	−0.2
Money supply	%	−0.7	2.4	7.7	13.2	18.3	22.5
OECD economies							
Real GNP	%	−10.5	−8.1	−6.3	−5.0	−3.9	−3.0
Inflation	D	9.8	5.7	4.5	3.7	3.0	2.4
Nominal interest rate	D	16.6	13.3	10.6	8.4	6.8	5.6
Trade balance	%GNP	0.3	0.1	0.0	−0.1	−0.1	−0.1
Budget deficit	%GNP	1.2	0.9	0.7	0.5	0.2	0.1
Money supply	%	−1.4	0.8	5.6	10.8	15.7	19.9

We can make a formal comparison of the outcomes of the four regimes by measuring the intertemporal welfare function, starting in 1984, for all of the countries, given the different adjustment paths. The results of this comparison are as follows:

	U.S.	Japan	ROECD
Cooperative case	−14.884	−13.416	−14.626
Noncooperative case	−14.983	−13.441	−14.886
Dollar standard	−15.381	−14.286	−15.644
Modified McKinnon	−14.739	−14.239	−14.695

Comparing the noncooperative with the cooperative case we see that each country has a lower loss under cooperation. The dollar standard leads uniformally to the largest loss. For the United States and the ROECD, the McKinnon rule performs well relative to the noncooperative case, but it is worse for Japan. The ranking of noncooperation and the McKinnon rule is therefore ambiguous.

The results have shown that national welfare in responding to an exogenous shock will be altered by the nature of the monetary regime,

and that at least for one shock (a global inflationary disturbance), the symmetric fixed exchange rate regime envisioned by McKinnon might have some merit. However, it is extremely inappropriate to draw conclusions about the relative merits of exchange rate regimes from one type of shock. In the next section we enrich the comparison among regimes by using a technique that allows us to examine regime performance under a variety of disturbances.

3.6 Asymptotic Properties of Alternative Regimes

Our second approach to comparing interactions under alternative exchange regimes uses a technique developed in McKibbin and Sachs (1985), in which we calculate the steady-state variances of a set of targets when the model is subject to a range of stochastic shocks, and when national policymakers optimize their policy choices with respect to a social welfare function. Related methods have been employed by Currie and Levine (1985). In the illustration in this section, the stochastic shocks are included in equations for aggregate demand, prices, and money demand in both the United States and the ROECD. It is assumed that in each period the shocks hit after the policies are in place, so that the policy choices are not conditioned on the realizations of the disturbances hitting the system within the period.

Under our assumption of an additively separable, quadratic social welfare function, average operating welfare of an economy in a particular monetary regime can be written in terms of the variances and covariances of the target variables under the particular regime. The numerical techniques in this section allow us to determine the asymptotic variance/covariance matrices for the target variables for each of the countries, and thereby to determine the average welfare levels of the economies under each of the regimes. For each regime, we proceed as follows. Optimal rules of adjustment, in the form

$$U_t^i = \Gamma^i X_t \qquad i = \text{United States, ROECD, and Japan}$$

are calculated for each country, using the dynamic programming solutions shown in section 3.5. We may then substitute these rules back into the structural equations of the model. Given the asymptotic variance/covariance structure of the shocks, we can then solve for the asymptotic variance/covariance structure of the target variables. Given these results, it is possible to calculate the asymptotic level of expected welfare for each country under each regime by a method described later in this section. In this way we can find out which regimes are most attractive independent of the initial conditions of the economy, in other words, in the long-run operating characteristics.

Since the technique is somewhat technical, it is worth spelling out in some detail. Once again, we begin with the state-space representation of the model, as reproduced here from equations 7 to 9:

(7′) $$X_{t+1} = AX_t + Be_t + CU_t + Z\epsilon$$

(8′) $${}_t(e_{t+1}) = DX_t + Fe_t + GU_t + W\epsilon_t$$

(9′) $$\tau_t = MX_t + Le_t + NU_t + O\epsilon_t$$

We now make several assumptions about the stochastic disturbances. They all enter additively so certainty equivalence holds. All shocks have persistent effects in the model. This is because the shocks enter into dynamic equations which cause the effects of the shocks to propagate over time. The shocks to the aggregate demand equation (ϵ^a) are entered explicitly in the following way:

$$\mu_{t+1} = .75\ (\mu_t) + \epsilon^a{}_t$$

where μ_t becomes part of the state vector X_t.

The other shocks, although serially uncorrelated, are persistent because of the dynamic specification of the model: the price shocks are built into a wage-price spiral in the model, and disturbances to money demand affect future money demand because of a lagged adjustment specification of the money demand equation (which makes the future demand for real money balances a function of the lagged level of real money balances).

The shocks also satisfy the following conditions:

$$E_{t-1}(\epsilon_t) = 0$$
$$E_{t-1}(\epsilon_t \epsilon_t{}^T) = \Sigma$$

Policy rules are written in the form:

(10′) $$U_t = \Gamma_1 X_t$$

where U_t is the stacked vector consisting of the policy instruments of the individual regions, U^i_t, $i =$ United States, ROECD, and Japan.

The policy rule may be the result of an optimization procedure (the case that we study in this section), or may be chosen by some other arbitrary technique. In other words, the technique in the section can be used to analyze each individual's favorite "optimal" policy rule, whether or not that rule is derived from a formal optimization procedure.

Given a specification of a policy rule, and given the structural equations of the system in equations (7′) to (9′), we find the stable manifold for the "jumping" variables e_t:

(11) $$e_t = H_1 X_t + H_2 \epsilon_t$$

(This equation can be derived through various procedures, including the closed-form solutions of Blanchard and Kahn [1980], or by various iterative techniques, one of which we have developed and used here). Then, by substituting (11) into (7′):

(12) $$X_{t+1} = \bar{A}X_t + \bar{Z}\epsilon_t$$

where $$\bar{A} = A + BH_1 + C\Gamma_1$$

and $$\bar{Z} = Z + BH_2$$

With the system written in the canonical form of a first-order stochastic difference equation, as in (12), it is straightforward, though tedious, to calculate the asymptotic variance/covariance structure of the state variables X. Once these are calculated, it is possible to use the equation for the target variables τ, in order to calculate the variance/covariance matrix of the target variables. A full description of the numerical techniques used to get to this point is provided in McKibbin and Sachs (1985).

Once the variance/covariance matrix of the target variables is known, we can also calculate the expected utility loss given some arbitrary welfare function.

$$\text{Let } \Pi = E(\tau\tau^T), \text{ and utility } U = \sum_{t=0}^{\infty} \beta^t \tau^T W \tau$$

where W is a diagonal matrix with weights for each target along the diagonal. Then,

(13) $$E(\tau^T W \tau) = TrE(W\tau\tau^T) = Tr(W\Pi).$$

Thus we find

(14) $$E(U) = Tr(W\Pi)/(1 - \beta)$$

Using the procedures just outlined we can now calculate the variance of targets under the alternative monetary regimes. For each regime, we calculate optimal policy rules of the form given in equation (10), and then we derive the asymptotic variance/covariance structures of the target variables. Rather than summarizing the results by presenting a single expected welfare level for each regime, as in equation (14), we instead report the asymptotic variances of the key variables, so that the reader can see how well the alternative regimes do in stabilizing the target variables in the world economy. (For convenience, the results are actually reported as standard deviations, rather than variances.)

These results are reported in tables 3.11 to 3.13, which present the standard deviations of output, inflation, the current account and the fiscal deficit in the United States and the ROECD, given shocks to

Table 3.11 Standard Deviation of Targets under Aggregate Demand Shocks

	Pure float	Cooperative float	Noncooperative float	McKinnon I	McKinnon II
			U.S. Demand Shock		
U.S.					
Output	2.164	1.534	1.490	3.253	3.197
Inflation	0.932	0.539	0.508	1.276	1.221
Current account	0.678	0.584	0.636	0.590	0.629
Fiscal deficit	0.010	0.255	0.108	1.518	1.382
ROECD					
Output	1.039	0.729	0.764	0.950	0.995
Inflation	0.621	0.433	0.458	0.372	0.525
Current account	0.557	0.474	0.525	0.497	0.530
Fiscal deficit	0.002	0.048	0.093	0.506	0.905
			ROECD Demand Shock		
U.S.					
Output	1.031	0.629	0.627	0.651	0.673
Inflation	0.648	0.408	0.406	0.217	0.376
Current account	0.251	0.236	0.234	0.222	0.352
Fiscal deficit	0.015	0.053	0.089	0.355	0.803
ROECD					
Output	2.114	1.383	1.382	3.636	3.554
Inflation	0.929	0.456	0.456	1.407	1.342
Current account	0.300	0.319	0.329	0.352	0.498
Fiscal deficit	0.003	0.037	0.054	1.635	1.168

aggregate demand, prices, and monetary velocity in each of these regions. Each row of numbers in the tables correspond to the asymptotic standard error of each target when the economy is subject to a given stochastic shock, within a given monetary regime. Results are reported for five types of monetary regimes: (1) a pure float, in which no policy actions are taken in any country (i.e., pure laissez-faire); (2) a cooperative float, in which all of the instruments in all of the countries are cooperatively controlled by a central authority, who maximizes a weighted sum of regional utilities; (3) a noncooperative float, in which monetary and fiscal policies are selected in a noncooperative way by the macroeconomic authorities in each of the countries; (4) the simple

Table 3.12 Standard Deviation of Targets under Price Shocks

	Pure float	Cooperative float	Noncooperative float	McKinnon I	McKinnon II
			U.S. Price Shock		
U.S.					
Output	2.723	1.771	1.783	2.465	2.187
Inflation	1.229	1.418	1.418	1.415	1.439
Current account	0.377	0.266	0.278	0.692	0.670
Fiscal deficit	0.012	0.083	0.150	1.346	1.111
ROECD					
Output	0.517	0.198	0.185	0.318	0.399
Inflation	0.374	0.163	0.157	0.236	0.562
Current account	0.295	0.212	0.229	0.585	0.578
Fiscal deficit	0.002	0.119	0.040	0.419	0.812
			ROECD Price Shock		
U.S.					
Output	0.664	0.274	0.230	0.302	0.280
Inflation	0.417	0.207	0.176	0.153	0.530
Current account	0.149	0.134	0.092	0.235	0.469
Fiscal deficit	0.005	0.118	0.044	0.310	0.758
ROECD					
Output	2.972	1.899	1.922	2.952	2.624
Inflation	1.281	1.482	1.504	1.637	1.597
Current account	0.164	0.171	0.139	0.350	0.566
Fiscal deficit	0.001	0.159	0.202	1.745	1.189

McKinnon rule (I), with fixed exchange rates and a constant level of global money; and (5) a modified McKinnon rule (II), in which the global money is cooperatively controlled in the way outlined in section 3.5.

Consider, for example, the effects of a unit shock to U.S. aggregate demand, under the alternative regimes given in table 3.11. The standard deviation of the shock itself is 1% of U.S. GDP (the corresponding shock in the ROECD has a standard deviation of one percent of ROECD GDP). Under a pure laissez-faire float, (denoted "pure float" in the

Table 3.13 **Standard Deviation of Targets under Money Velocity Shocks**

	Pure float	Cooperative float	Noncooperative float	McKinnon I	McKinnon II
			U.S. Money Shock		
U.S.					
Output	1.628	1.546	1.550	0.631	0.633
Inflation	0.505	0.604	0.607	0.233	0.276
Current account	0.162	0.168	0.174	0.077	0.063
Fiscal deficit	0.001	0.041	0.070	0.164	0.019
ROECD					
Output	0.272	0.122	0.126	0.936	0.888
Inflation	0.112	0.046	0.048	0.337	0.347
Current account	0.153	0.162	0.168	0.094	0.081
Fiscal deficit	0.000	0.055	0.006	0.267	0.060
			ROECD Money Shock		
U.S.					
Output	0.291	0.060	0.039	0.629	0.630
Inflation	0.113	0.068	0.055	0.234	0.275
Current account	0.068	0.058	0.033	0.079	0.063
Fiscal deficit	0.002	0.071	0.015	0.172	0.019
ROECD					
Output	2.184	1.955	1.976	0.935	0.885
Inflation	0.666	0.772	0.787	0.339	0.346
Current account	0.086	0.068	0.054	0.094	0.081
Fiscal deficit	0.001	0.086	0.108	0.284	0.060

table), the unit shock to aggregate demand induces an asymptotic standard deviation in real output in the United States of 2.164% of GDP. Under a global cooperative arrangement, the standard deviation is reduced to 1.534% of U.S. GDP. If the United States is stabilizing by itself, in a noncooperative flexible exchange rate regime, and if the stabilization is such as to minimize the social welfare function introduced earlier, then the variability of U.S. GDP due to pure demand shocks is reduced still further, to 1.490% of U.S. GDP. The shock, of course, also induces fluctuations in inflation and in the current account-

GDP ratio (the table records the standard deviation of both of these variables when measured in percentage points; i.e., the standard deviation of 0.932 in U.S. inflation signifies a standard deviation of just under one percentage point of annual inflation).

The key point in table 3.11 is that the fixed exchange rate systems (McKinnon I and McKinnon II) are destabilizing for the real GDPs of both the United States and the ROECD when U.S. aggregate demand is hit by stochastic shocks. In a floating rate system, some of the demand shock is automatically muted as the floating rate appreciates and thereby shifts some of aggregate demand abroad. Under the McKinnon rule, however, if the United States is hit by a positive aggregate demand shock, the U.S. money supply automatically expands, enough to forestall any appreciation of the exchange rate. The demand shock is then magnified in the United States, as it is amplified by a monetary expansion. Abroad, we have already seen, the foreign money supply contracts under the rules of the game, and the foreign economy actually slumps. For this kind of shock, it doesn't really matter whether the global money stock is fixed (as in the McKinnon I) or varied cooperatively (as in McKinnon II), though it is not clear to us why there is not more gain to a coordinated monetary response. Note, finally, that some policy is better than none, since the cooperative and noncooperative floating rate policies dominate the laissez-faire response in all cases.

When we turn our attention to price shocks, in table 3.12, little of this conclusion is changed. In almost all cases, cooperative or noncooperative floating is better than either laissez-faire or a fixed exchange rate. This result is really not surprising, in that a nominal price or wage shock in one country (due, for example, to a temporary productivity decline, to wage militancy, etc.) is best absorbed in the world markets through a depreciation of the currency of the inflating country. In this way, there is a substantial gain in the stability of real output, with only a slight decline in the stability of the inflation rate (note that the laissez-faire policies and the pure McKinnon rule have a very slightly lower variance of inflation than do the floating rate rules).

Why is it that the McKinnon rule seemed stabilizing in the inflation game of section 3.5, but seems rather unattractive in the present context? The reason is that the previous game studied a case in which all countries simultaneously are faced with a price shock, whereas in table 3.12 the price shocks in the United States or the ROECD are considered to be independently distributed. This distinction is potentially very important in that when the price shocks are independent, it is useful to allow for nominal exchange rate variability across the countries, while when the shocks are highly correlated, the need for exchange rate movements is very much reduced, and the benefit to reducing

cross-country strategic actions that cancel each other out, is likewise increased. For that reason, the methodology in this section is somewhat biased against a fixed exchange rate system.

Table 3.13 refers to velocity shocks in the money demand equations in the United States and the ROECD. Once again, we study the case in which the shocks are independently distributed. Now we have an interesting and intuitively plausible finding: a fixed rate regime stabilizes the economy of the country that experiences the monetary shock, but destabilizes the economy of the other country. Consider concretely what happens when U.S. money demand rises, under the alternative systems (remember that the shock is unobserved within the period that it occurs). Under floating rates, the economy with rising money demand experiences a currency appreciation and a corresponding decline in aggregate demand, resulting from the fall in national competitiveness. The other economies experience either a modest gain or fall in output: competitiveness improves, but export markets shrink since the economy with rising money demand goes into recession. Now, under a McKinnon rule, the economy with rising money demand would automatically have an accommodating increase in money, as the monetary authority expands money enough to keep the exchange rate pegged. The other economy, however, would be forced to contract the money supply under the rules of the game, so that its economy could be greatly destabilized.

Once again, the conclusions would look much more appealing to the McKinnon rule once we allow for a negative correlation across countries in the money shocks. Suppose, for example, that the money shocks in the United States and the ROECD are perfectly negatively correlated. The results for this case are given in table 3.14. In this case the McKinnon rule is close to being perfectly stabilizing, since the country with expanding money demand automatically has a rising money supply, while the country with the contracting money demand automatically has a falling money supply. The other regimes perform far worse than the McKinnon rule for this particular type of shock, which indeed is the type of shock stressed by McKinnon.

A full analysis of the costs and benefits of the alternative systems would require a more complete investigation of the covariance structure of the underlying shocks, something that we hope to do in future work.

3.7 Conclusions

This chapter has analyzed the implications of alternative monetary regimes in the OECD for the transmission of fiscal policy and for the efficiency of strategic interactions across the major OECD economies. While the work is tentative, we have already arrived at several useful

Table 3.14 Standard Deviation of Targets under Negatively Correlated U.S. and ROECD Money Shocks

	Pure float	Cooperative float	Noncooperative float	McKinnon I	McKinnon II
U.S.					
Output	1.608	1.490	1.518	0.002	0.002
Inflation	0.430	0.549	0.569	0.001	0.001
Current account	0.174	0.188	0.176	0.000	0.000
Fiscal deficit	0.004	0.111	0.058	0.000	0.000
ROECD					
Output	2.386	2.076	2.101	0.003	0.003
Inflation	0.680	0.794	0.812	0.001	0.001
Current account	0.135	0.173	0.164	0.000	0.000
Fiscal deficit	0.001	0.141	0.103	0.001	0.000

conclusions. First, the nature of fiscal interactions will vary greatly depending on the nature of the monetary regime. Under floating exchange rates, transmission of fiscal policy tends to be positive, while under a fixed rate system, of the sort propounded by McKinnon, fiscal policy can actually be negatively transmitted. In asymmetric monetary systems, such as a dollar standard, U.S. fiscal policy may well be negatively transmitted, while foreign fiscal policy is almost surely positively transmitted to the United States. These theoretical findings are supported by simulation experiments in a large-scale multiregion model of the world economy (the MSG model). The quantitative estimates show that negative transmission of fiscal policy under a fixed exchange rate regime is more than a theoretical curiosity and is at the least a real empirical possibility, if not likelihood.

One of the alleged advantages of a move to fixed exchange rates is that it would mute the incentives for beggar-thy-neighbor policies under flexible exchange rates. We illustrated that proposition in two ways, first using a simple theoretical model, and, second, by examining a differential game in which the large three OECD regions all inherit a high inflation rate and then use macroeconomic policies in the attempt to pursue an optimal disinflation. As we show, the noncooperative floating regime tends to create an incentive toward fiscal expansion and monetary contraction that is inefficient from the point of view of the social welfare functions in the individual countries.

A new methodology is used at the end to examine the "average" operating properties of the alternative systems. The question of which system is best is shown to depend on which stochastic disturbances are dominant, a standard result in the analysis of fixed versus flexible rates. The results, on the whole, are relatively hostile to fixed exchange rates, but that might depend on our specification of the shocks. As is described in the text, price shocks that are positively correlated across countries, or money demand shocks that are negatively correlated across countries, will both tend to be relatively well handled by fixed exchange rate regimes.

Appendix
MSG Model of the World Economy

U.S. Equations

$$Q^U = D^U + G^U + (C^O_U + C^J_U + C^L_U + C^P_U) - (\Lambda^O C^U_O + \Lambda^J C^U_J + \Lambda^L C^U_L + \Lambda^P C^U_P)$$

$$\Lambda^O = P^O E^O / P^U$$

$$\Lambda^J = P^J E^J / P^U$$

$$\Lambda^L = P^L / P^U$$

$$\Lambda^P = P^P / P^U$$

$$D^U = (1 - s)(Q^U - T^U) + \delta H^U - .5 v r^U - .5 v R^U$$

$$H^U = B^U + A^U_L - A^O_U - A^P_U - A^J_U$$

$$B^U_{t+1} = (B^U_t + \mathrm{DEF}^U_t)/(1 + n)$$

$$\mathrm{DEF}^U = G^U + r^U B^U - v^U B^U_L - T^U$$

$$M^U_t / P^U_t = \{Q^{U\phi}_t (1 + i^U_t)^{-\beta}\}^{.5} \{M^U_{t-1}/P^U_{t-1}\}^{.5}$$

$$i^U_t = r^U_t + \pi^U_{t+1}$$

$$r^U_t = R^U_t - ({}_tR^U_{t+1} - R^U_t)/R^U_t$$

$$v^U_t = .13 r^U_t + .82 v^U_{t-1}$$

$$\pi^U_{t+1} = (P^U_{t+1} - P^U_t)/P^U_t$$

$$\pi^{CU}_{t+1} = (P^{CU}_{t+1} - P^{CU}_t)/P^{CU}_t$$

$$\pi^U_{t+1} = \pi^{CU}_t + \Omega Q^U_t + \tau(Q^U_t - Q^U_{t-1})$$

$$P^{CU} = (P^U)^{\gamma_1}(P^O E^O)^{\gamma_2}(P^L)^{\gamma_3}(P^J E^J)^{\gamma_4}(P^P)^{(1-\gamma_1-\gamma_2-\gamma_3-\gamma_4)}$$

$$C_O^U = \alpha_O(D^U + G^U)(\Lambda^O)^{-1.5}$$

$$C_L^U = \alpha_1(D^U + G^U)(\Lambda^L)^{-1.0}$$

$$C_P^U = \alpha_2(D^U + G^U)(\Lambda^P)^{-0.2}$$

$$C_J^U = \alpha_3(D^U + G^U)(\Lambda^J)^{-1.5}$$

$$TB^U = (C_U^O + C_U^L + C_U^P + C_U^J) - (C_O^U\Lambda^O + C_L^U\Lambda^L + C_P^U\Lambda^P + C_J^U\Lambda^J)$$

Japan Equations

$$Q^J = D^J + G^J + (C_J^U + C_J^O + C_J^L + C_J^P) - (C_U^J + C_O^J\Lambda^O + C_L^J\Lambda^L + C_P^J\Lambda^P)/\Lambda^J$$

$$D^J = (1 - s^J)(Q^J - T^J) - vr^J + \delta H^J$$

$$H^J = B^J + A_U^J/\Lambda^J + A_{LJ}^J + A_{LU}^J/\Lambda^J - A_J^P$$

$$B_{t+1}^J = (B_t^J + \text{DEF}_t^J)/(1 + n)$$

$$\text{DEF}^J = G^J + r^J B^J - v^J B_L^J - T^J$$

$$M_t^J/P_t^J = \{Q_t^{J\phi}(1 + i_t^J)^{-\beta}\}^{.5}\{M_{t-1}^J/P_{t-1}^J\}^{.5}$$

$$i_t^J = r_t^J + \pi_{t+1}^J$$

$$v_t^J = .82v_{t-1}^J + .13r_t^J$$

$$\pi_{t+1}^J = (P_{t+1}^J - P_t^J)/P_t^J$$

$$\pi_{t+1}^{CJ} = (P_{t+1}^{CJ} - P_t^{CJ})/P_t^{CJ}$$

$$\pi_{t+1}^J = \pi_t^{CJ} + \Omega Q_t^J + \tau(Q_t^J - Q_{t-1}^J)$$

$$P^{CJ} = (P^J)^{\gamma_5}(P^U/E^J)^{\gamma_6}(P^O E^O/E^J)^{\gamma_7}(P^L/E^J)^{\gamma_8}(P^P/E^J)^{(1-\gamma_5-\gamma_6-\gamma_7-\gamma_8)}$$

$$C_U^J = \alpha_4(D^J + G^J)(\Lambda^J)^{1.5}$$

$$C_O^J = \alpha_5(D^J + G^J)(\Lambda^O/\Lambda^J)^{-1.5}$$

$$C_L^J = \alpha_6(D^J + G^J)(\Lambda^L/\Lambda^J)^{-1.0}$$

$$C_P^J = \alpha_7(D^J + G^J)(\Lambda^P/\Lambda^J)^{-0.2}$$

$$TB^J = \Lambda^J(C_J^U + C_J^O + C_J^L + C_J^P) - (C_U^J + \Lambda^O C_O^J + \Lambda^L C_L^J + \Lambda^P C_P^J)$$

$$A_{Ut+1}^J = (A_{Ut}^J + CA_t^J)/(1 + n) - [(A_{LJt+1}^J\Lambda_t^J + A_{LUt+1}^J + B_{Lt+1}^J\Lambda_t^J - A_{Jt+1}^P\Lambda_t^J) - (A_{LJt}^J\Lambda_t^J + A_{LUt}^J + B_{Lt}^J\Lambda_t^J - A_{Jt}^P\Lambda_t^J)/(1 + n)]$$

$$CA^J = TB^J + r^U(A_U^J + A_{LU}^J) + r^J\Lambda^J A_{LJ}^J + v^J\Lambda^J B_L^J - r^J\Lambda^J A_J^P$$

$$(A_{Ut}^J + A_{LUt}^J)/\Lambda_t^J = \sigma^J[r_t^U - r_t^J - ({}_t\Lambda_{t+1}^J - \Lambda_t^J)/\Lambda_t^J] + \theta H_t^J$$

ROECD Equations

$$Q^O = D^O + G^O + (C^U_O + C^L_O + C^P_O + C^J_O) - (C^O_U + C^O_J\Lambda^J + C^O_L\Lambda^L + C^O_P\Lambda^P)/\Lambda^O$$

$$D^O = (1 - s)(Q^O - T^O) - vr^O + \delta H^O$$

$$H^O = B^O + A^O_U/\Lambda^O + A^O_L - A^P_O/\Lambda^O$$

$$B^O_{t+1} = (B^O_t + \mathrm{DEF}^O_t)/(1 + n)$$

$$\mathrm{DEF}^O = G^O + r^OB^O - v^OB^O_L - T^O$$

$$M^O_t/P^O_t = \{Q^{O\phi}_t(1 + i^O_t)^{-\beta}\}^{.5}\{M^O_{t-1}/P^O_{t-1}\}^{.5}$$

$$i^O_t = r^O_t + \pi^O_{t+1}$$

$$v^O_t = .13r^O_t + .82v^O_{t-1}$$

$$\pi^O_{t+1} = (P^O_{t+1} - P^O_t)/P^O_t$$

$$\pi^{CO}_{t+1} = (P^{CO}_{t+1} - P^{CO}_t)/P^{CO}_t$$

$$\pi^O_{t+1} = \pi^{CO}_t + \Omega Q^O_t + \tau(Q^O_t - Q^O_{t-1})$$

$$P^{CO} = (P^O)^{\gamma_9}(P^U/E^O)^{\gamma_{10}}(P^L/E^O)^{\gamma_{11}}(P^JE^J/E^O)^{\gamma_{12}}(P^P/E^O)^{(1-\gamma_9-\gamma_{10}-\gamma_{11}-\gamma_{12})}$$

$$C^O_U = \alpha_8(D^O + G^O)(\Lambda^O)^{1.5}$$

$$C^O_J = \alpha_9(D^O + G^O)(\Lambda^J/\Lambda^O)^{-1.5}$$

$$C^O_L = \alpha_{10}(D^O + G^O)(\Lambda^L/\Lambda^O)^{-1.0}$$

$$C^O_P = \alpha_{11}(D^O + G^O)(\Lambda^P/\Lambda^O)^{-0.2}$$

$$TB^O = (C^U_O + C^L_O + C^P_O + C^J_O) - (C^O_U + C^O_J\Lambda^J + C^O_L\Lambda^L + C^O_P\Lambda^P)/\Lambda^O$$

$$A^O_{Ut+1} = (A^O_{Ut} + CA^O_t)/(1 + n) - [(A^O_L + B^O_L)_{t+1}\Lambda^O_t - (A^O_L + B^O_L)_t\Lambda^O/(1 + n) - A^P_{Ot+1} + A^P_{Ot}/(1 + n)]$$

$$CA^O = (A^O_U - A^P_O)r^U + (A^O_L\Lambda^O)r^O + (B^O_L\Lambda^O)v^O + TB^O\Lambda^O$$

$$(A^O_U - A^P_O)_t/\Lambda^O_t = \sigma[r^U_t - r^O_t - ({}_t\Lambda^O_{t+1} - \Lambda^O_t)/\Lambda^O_t] + \theta H^O_t$$

LDC Equations

$$P^L = (P^U)^{\eta_1}(P^OE^O)^{\eta_2}(P^JE^J)^{-\eta_3}(P^P)^{(1-\eta_1-\eta_2-\eta_3)}(C^U_L + C^O_L + C^P_L + C^J_L)^{\gamma L}$$

$$C^L_U = \eta_1(C^L_U + \Lambda^OC^L_O + \Lambda^PC^L_P + \Lambda^JC^L_J)$$

$$C^L_O = \eta_2(C^L_U + \Lambda^OC^L_O + \Lambda^PC^L_P + \Lambda^JC^L_J)/\Lambda^O$$

$$C^L_J = \eta_3(C^L_U + \Lambda^OC^L_O + \Lambda^PC^L_P + \Lambda^JC^L_J)/\Lambda^J$$

$$C^L_P = (1 - \eta_1 - \eta_2 - \eta_3)(C^L_U + \Lambda^OC^L_O + \Lambda^PC^L_P + \Lambda^JC^L_J)/\Lambda^P$$

$$TB^L = \Lambda^L(C^U_L + C^O_L + C^P_L + C^J_L) - C^L_U - \Lambda^O C^L_O - \Lambda^P C^L_P - \Lambda^J C^L_J$$

$$CA^L_t = \omega CA^L_{t-1} + \epsilon\{\mathrm{DEBT}_t - \xi\Lambda^L_t(C^O_{Lt} + C^U_{Lt} + C^P_{Lt} + C^J_{Lt}) \cdot [1 + \mathrm{n}(1 - \omega)/\epsilon]\}$$

$$\mathrm{DEBT}_t = A^U_L + (A^O_L\Lambda^O) + A^P_L + B^U_L + (B^O_L\Lambda^O) + A^J_{LU} + A^J_{LJ}\Lambda^J + B^J_L\Lambda^J$$

$$B^U_{Lt+1} = B^U_{Lt} + .1[A^U_{Lt+1}(1 + n) - A^U_{Lt}]$$

$$B^O_{Lt+1} = B^O_{Lt} + .1[A^O_{Lt+1}(1 + n) - A^O_{Lt}]$$

$$\Lambda^J_t B^J_{Lt+1} = \Lambda^J_t B^J_{Lt} + .1[(A^J_{LJt+1}\Lambda^J_t + A^J_{LUt+1})(1 + n) - (A^J_{LJt}\Lambda^J_t + A^J_{LUt})]$$

$$A^O_{Lt+1}\Lambda^O_t = \{a_1[(A^U_{Lt+1} + A^O_{Lt+1}\Lambda^O_t + A^P_{Lt+1} + A^J_{LJt+1}\Lambda^J_t + A^J_{LUt+1})(1 + n) - (A^U_{Lt} + A^O_{Lt}\Lambda^O_t + A^P_{Lt} + A^J_{LJt}\Lambda^J_t + A^J_{LUt})] + A^O_{Lt}\Lambda^O_t\}/(1 + n)$$

$$A^P_{Lt+1} = \{a_2[(A^U_{Lt+1} + A^O_{Lt+1}\Lambda^O_t + A^P_{Lt+1} + A^J_{LJt+1}\Lambda^J_t + A^J_{LUt+1}) \cdot (1 + n) - (A^U_{Lt} + A^O_{Lt}\Lambda^O_t + A^P_{Lt} + A^J_{LJt}\Lambda^J_t + A^J_{LUt})] + A^P_{Lt}\}/(1 + n)$$

$$A^J_{LJt+1}\Lambda^J_t = \{a_3[(A^U_{Lt+1} + A^J_{LJt+1}\Lambda^J_t + A^J_{LUt+1} + A^O_{Lt+1}\Lambda^O_t + A^P_{Lt+1})(1 + n) - (A^U_{Lt} + A^J_{LJt}\Lambda^J_t + A^J_{LUt} + A^O_{Lt}\Lambda^O_t + A^P_{Lt})] + A^J_{LJt}\Lambda^J_t\}/(1 + n)$$

$$A^J_{LUt+1} = \{a_4[(A^U_{Lt+1} + A^J_{LJt+1}\Lambda^J_t + A^J_{LUt+1} + A^O_{Lt+1}\Lambda^O_t + A^P_{Lt+1}) (1 + n) - (A^U_{Lt} + A^J_{LJt}\Lambda^J_t + A^J_{LUt} + A^O_{Lt}\Lambda^O_t + A^P_{Lt})] + A^J_{LUt}\}/(1 + n)$$

$$A^U_{Lt+1} = (A^U_{Lt} + CA^L_t)/(1 + n) - [(A^J_{LJt+1}\Lambda^J_t + A^J_{LUt+1} + A^O_{Lt+1}\Lambda^O_t + A^P_{Lt+1} + B^U_{Lt+1} + B^J_{Lt+1}\Lambda^J_t + B^O_{Lt+1}\Lambda^O_t) - (A^J_{LJt}\Lambda^J_t + A^J_{LUt} + A^O_{Lt}\Lambda^O_t + A^P_{Lt} + B^U_{Lt} + B^J_{Lt}\Lambda^J_t + B^O_{Lt}\Lambda^O_t)/(1 + n)]$$

OPEC Equations

$$P^P = (P^U)^{\eta_4}(P^O E^O)^{\eta_5}(P^J E^J)^{\eta_6}(P^L)^{(1-\eta_4-\eta_5-\eta_6)} (C^U_P + C^O_P + C^L_P + C^J_P)^{\gamma P}$$

$$C^P_U = \eta_4(C^P_U + \Lambda^O C^P_O + \Lambda^L C^P_L + \Lambda^J C^P_J)$$

$$C^P_O = \eta_5(C^P_U + \Lambda^O C^P_O + \Lambda^L C^P_L + \Lambda^J C^P_J)/\Lambda^O$$

$$C^P_J = \eta_6(C^P_U + \Lambda^O C^P_O + \Lambda^L C^P_L + \Lambda^J C^P_J)/\Lambda^J$$

$$C^P_L = (1 - \eta_4 - \eta_5 - \eta_6)(C^P_U + \Lambda^O C^P_O + \Lambda^L C^P_L + \Lambda^J C^P_J)/\Lambda^L$$

$$H^P = A^P_U + A^P_O + A^P_L + A^P_J\Lambda^J$$

$$TB^P = \Lambda^P(C^U_P + C^O_P + C^L_P + C^J_P) - C^P_U - \Lambda^O C^P_O - \Lambda^L C^P_L - \Lambda^J C^P_J$$

$$CA^P_t = \zeta[\psi(C^U_P + C^O_P + C^L_P + C^J_P)_t(P^P/P^U)_t - H^P_{t-1}] + nH^P_{t-1}$$

$$A^P_{Ut+1} = (A^P_{Ut} + CA^P_t)/(1 + n) - [(A^P_O + A^P_L)_{t+1} + A^P_{Jt+1}\Lambda^J_t - (A^P_O + A^P_L + A^P_J\Lambda^J)_t/(1 + n)]$$

$$A^P_{Ot+1} = \{b_1[(A^P_U + A^P_O + A^P_L + A^P_J\Lambda^J_t)_{t+1}(1 + n) - (A^P_U + A^P_O + A^P_L + A^P_J\Lambda^P)_t] + A^P_{Ot}\}/(1 + n)$$

$$A^P_{Jt+1}\Lambda^J_t = \{b_2[(A^P_U + A^P_O + A^P_L + A^P_J\Lambda^J t)_{t+1}(1 + n) - (A^P_U + A^P_O + A^P_L + A^P_J\Lambda^J)_t] + A^P_{Jt}\Lambda^J_t\}/(1 + n)$$

Definitions

A^i_j	Claims on country j held by private creditors in country i
B^i_j	Claims on country j held by official creditors in country i
B^i	Government debt of country i
C^i_j	Consumption by country i of the output of country j
CA	Current account
D	Domestic absorption
DEBT	Developing country debt
DEF	Government deficit
E^O	Exchange rate ($/Ecu)
E^J	Exchange rate ($/yen)
G	Government expenditure
H	Real financial wealth
i	Nominal interest rate
M	Nominal money supply
n	Growth rate
P^i	Price level of country i goods
P^C	Consumer price index
π_t	Domestic price inflation
π^C_t	Consumer price inflation
Q	Gross domestic product
r	Real short interest rate
R	Real long interest rate
T	Taxes
TB	Trade balance
v	Concessional real interest rate
Λ	Real exchange rate
${}_tX_{t+1}$	Expectation of X_{t+1} based on period t information

Superscripts and Subscripts

U	United States
O	Rest of OECD
J	Japan
L	Developing Countries
P	OPEC

Parameter Values

S	= 0.3	γ_6	= 0.022	α_7	= 0.039	γ_L	= 0.5
S^J	= 0.5	γ_7	= 0.020	α_8	= 0.032	γ_P	= 0.5
ν	= 0.2	γ_8	= 0.026	α_9	= 0.010	a_1	= 0.110
δ	= 0.1	γ_9	= 0.911	α_{10}	= 0.028	a_2	= 0.230
n	= 0.03	γ_{10}	= 0.032	α_{11}	= 0.019	a_3	= 0.010
ϕ	= 0.8	γ_{11}	= 0.028	σ	= 4	a_4	= 0.130
β	= 0.9	γ_{12}	= 0.010	σ^J	= 1	b_1	= 0.226
Ω	= 0.2	α_0	= 0.034	θ	= 0.5	b_2	= 0.070
τ	= 0.2	α_1	= 0.024	η_1	= 0.195	ω	= 0.9
γ_1	= 0.922	α_2	= 0.008	η_2	= 0.353	ϵ	= 0.3
γ_2	= 0.034	α_3	= 0.013	η_3	= 0.145	ξ	= 1.985
γ_3	= 0.024	α_4	= 0.022	η_4	= 0.092	ψ	= 1.65
γ_4	= 0.013	α_5	= 0.020	η_5	= 0.323	ζ	= 0.29
γ_5	= 0.893	α_6	= 0.026	η_6	= 0.109		

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Comment William H. Branson

This paper begins by reviewing some basic analytical results on the transmission of disturbances between economies under alternative exchange rate regimes. These are the basis for the case for coordination; it is expected to reduce the negative effects of transmission. The paper then goes on to report numerical results for simulation using the global model developed by McKibbin and Sachs, which the authors dub the MSG model. The model-based results progress from simple illustrations of transmission in section 3.3 to optimal coordination results in sections 3.5 and 3.6. Readers of the paper should keep in mind that the authors, while referring to the model as "empirical," are also careful to point out that the parameters of the model are not estimated but "chosen to be consistent with values found in the empirical literature" (sec. 3.3). In a sense, then, the paper is rather more about the model, and less about the effect of coordination in the world, than would be the case if the model were actually estimated. By the end of the paper the reader

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knows quite a lot about the model, and may even feel a little overdosed on MSG!

In this comment I offer a brief reader's guide to the paper, with my own views interspersed. This may help to lighten the MSG dosage. The comment ends with some observations on research on coordination, and the place of the McKibbin-Sachs work in this context.

The results of the basic Mundell model for the transmission of fiscal policy are reviewed in section 3.2 under three alternative exchange rate regimes—clean float, all others peg to the dollar, and modified McKinnon, with exchange rates and a weighted average of money stocks fixed. The analytical results are influenced by use of a fixed-price assumption. In the case of the clean float, fiscal policy is positively transmitted; an increase in spending in the United States raises interest rates and appreciates the dollar, giving a stimulus to net exports abroad. The European argument that this effect may be offset by the depressive effect of higher interest rates on investment is ruled out by the fixed-price assumption. In the money market equation (2), if $m^* - p^*$ is fixed, an increase in i requires an increase in q^* to maintain equilibrium. If p^* were permitted to rise, the positive transmission result would become ambiguous.

Under the dollar standard with the U.S. money stock fixed, foreign monetary policy must tighten to keep the dollar from appreciating. This produces an investment effect abroad that may offset the trade effect from the U.S. expansion. The result depends on the sign of $\gamma - \sigma\phi/\beta$, the q^* multiplier under the dollar standard. The econometric results in Branson (1984a, 1984b) suggest that the dollar standard results are most relevant. U.S. monetary policy seems focused on domestic targets, while European policy reacts to the exchange rate.

Under the modified McKinnon rule, exchange rates are fixed along with a weighted average world money supply. So with U.S. fiscal expansion, U.S. monetary policy is also eased, reducing the required tightening abroad to keep the dollar from appreciating. This procedure will work only in a world of perfect asset substitutability where only the ratio of money supplies matters for the exchange rate. This pure monetary model of exchange rate determination is under a heavy empirical cloud, however. In any event, the modified McKinnon rule provides a muted version of the dollar standard results, with negative transmission less likely.

The same experiments are performed in section 3.3 using the MSG simulation model, a computerized version of the dynamized Mundell model of Dornbusch (1976). It has sticky wages and prices, income-constrained consumers, and very high asset substitutability. The specification of the three OECD areas, United States, Japan, rest of OECD (ROECD), is fairly symmetric. This is surprising in view of Sachs's

(1979) own work on the asymmetries in wage behavior across these areas.

Tables 3.1, 3.3, and 3.5 confirm that the MSG computer can indeed reproduce the Dornbusch-Mundell results. With floating rates (table 3.1) and a fixed path of the U.S. money stock, a fiscal expansion in the United States raises interest rates and the Ecu and yen prices of the dollar, but also gives a short-run stimulus to real GNP in Japan and the ROECD. The wage and price reaction reverses this positive transmission after three years. With the dollar standard (table 3.3), the money stock and output fall in Japan and ROECD. Under the modified McKinnon rule (table 3.5), U.S. money increases, so that money tightens less in Japan and the ROECD, and the reduction in output is reduced.

The coordination part of the paper begins in section 3.4 with a two-country example of strategic interaction of policy in a modification of the static Mundell model of section 3.2. The crucial assumptions in this section are the shift to using the CPI with an import component as the price index, and inclusion of the fiscal deficit g explicitly in the welfare function of equation (5), as well as output q and the price index. The standard noncooperative game result is that each country reacts to a common inflation shock by tightening monetary policy and easing fiscal policy to get an offsetting price effect from the exchange rate. Of course they both fail; and, with no predictable effect on the exchange rate, they both end up with tighter money and easier fiscal policy than intended or expected, and a failed attempt at competitive appreciation.

McKibbin and Sachs introduce a suboptimal result for real outputs into the scenario by including the fiscal deficit in the welfare function. Now as each country eases fiscal policy, welfare falls. Note that g and $g*$ enter the welfare function symmetrically around their target levels. The fall in welfare induces each country to ease fiscal policy a little less, and to permit output q to absorb some of the welfare loss.

The inefficiency of this noncooperative game is eliminated by the modified McKinnon rule in this example. The essential argument is that fixing the exchange rate removes the temptation to manipulate it via monetary policy in order to offset an exogenous inflation shock. So there is no attempt to twist monetary and fiscal policy, and no need to trade off q against g in the welfare function. The optimal result is efficiently to swallow the exogenous inflation shock, rather than to attempt to dampen it via a competitive appreciation. The difficulty that arises here is the hidden problem of incentives. What eliminates the incentive for a monetary authority to try to cheat on the system a little? This problem is in the background for the rest of the paper.

In section 3.5, McKibbin and Sachs turn to strategic interactions and coordination using MSG. The welfare function of each area, specified

in equation (6), includes both the fiscal deficit and the current account balance explicitly. This implies that the specification of "bliss" includes national saving equal to domestic investment for each area. Inclusion of policy variables explicitly in the welfare function opens the possibility that differentiation among policy choices is built into the results by assumption.

The noncooperative solutions for policy using MSG assume each area chooses its fiscal rule taking the others as given, in the face of a common inflation shock. These are Nash equilibria for each of the monetary regimes. These can be compared with the cooperative regime where a world planner, or the Economic Policy Committee (EPC) of OECD, maximizes a GNP-weighted world welfare index. The noncooperative dollar standard solution has the United States maximizing on monetary and fiscal policy. This then constrains Japanese and ROECD monetary policy; so they maximize on fiscal policy only. In the modified McKinnon case, the EPC chooses a path for weighted world money, assuming optimal fiscal policies. This fixes world money, and then, in the noncooperative solution, each area chooses fiscal policy independently, taking the others as given. Again, the incentives that bind monetary authorities are not specified.

The MSG results for the common inflation shock are puzzling. Comparison of tables 3.7 and 3.8 for the floating rate cooperative and noncooperative solution reveals virtually no difference in the output or inflation paths. The main result of noncooperation is the twist toward tighter money and easier fiscal policy with higher interest rates. Presumably the slight superiority of the cooperative case on the welfare measure (section 3.5) comes from inclusion of the fiscal balance in the welfare measure. Comparison of tables 3.8 and 3.9 shows the inferiority of the dollar standard in the face of the inflation shock, but the explanation is not convincing. McKibbin and Sachs argue that the United States attempts to import disinflation in this case by engineering a disinflation abroad using tight money and fiscal ease in the United States. But under the dollar standard in table 3.9, Japanese real GNP and inflation are higher than with the floating rate, and GNP and inflation in the ROECD are about the same. The modified McKinnon rule removes the incentive for competitive appreciation, so the results resemble the cooperative flexible regime. As the welfare scores in section 3.5 show, there is not much difference among the two floating rate cases and the McKinnon rule in the disinflation game.

One of the main lessons from recent work on coordination is that the ranking of regimes depends on the source of disturbances. So in section 3.6 McKibbin and Sachs report the asymptotic variance of MSG under the alternative regimes with stochastic shocks to aggregate de-

mand, the price level, and the velocity of money, in alternatively the United States and the ROECD. In table 3.11 we see that the noncooperative float seems best for demand shocks, and in table 3.12 the cooperative and noncooperative floats share first place under price shocks. With money velocity shocks in one country, the McKinnon rule stabilizes the economy where the shock originates, by inducing an offsetting money supply response, but destabilizes the other economy. This is shown in table 3.13. But with negative correlation across countries in velocity shocks in table 3.14, the McKinnon rule dominates. This is as it should be, since the rule was designed for a world in which shifts of asset preference across currencies are the dominant source of disturbances.

What does the reader learn in this encounter with the McKibbin-Sachs global model? First, we see that with a heavy dose of MSG we can obtain sensible-looking numerical results that conform to intuition based on simple analytical models. This should increase confidence in the model's usefulness in analyzing policy alternatives. Second, we see that no regime dominates. The results depend on sources of shocks and probably also on the nature of the game that policymakers are playing. This makes it difficult to see how a coordination agreement could be negotiated internationally at the present time. Third, the noncooperative float looks like a fairly good regime. It would work especially well if central banks could agree to rule out competitive appreciation in the face of inflation shocks.

Research on monetary or macro policy coordination seems to be following three different paths. One is simulation study, taking empirical parameters *and* the institutional framework that would induce policymakers to join the specified cooperative game or set of rules as given. The present paper is on this path. A second is actual empirical work, attempting to estimate better models for the simulation studies to manipulate. The third path is the design of institutions that provide the incentives for policymakers to coordinate in productive ways. Perhaps further work with MSG or its descendants can contribute to this third line of research by developing regimes that offer policymakers such incentives.

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Comment Robert P. Flood

In this paper McKibbin and Sachs present some policy simulations using their global model. The model is listed in the paper's appendix, and its construction has been discussed elsewhere. Since the model is not treated specifically here, I will make no specific comments on it. I will, however, make three kinds of general comments about the paper. First, I will list and explain briefly some standard caveats concerning this type of simulation exercise. Second, I will discuss what I think are some problems associated with the arbitrary loss function adopted by the authors. Third, I will discuss a methodological problem with using this type of model for policy evaluation. My comments are all critical, but that should not be taken as a negative evaluation of the work. This paper is state-of-the-art, open-economy policy evaluation and is a quantum leap beyond many of its competitors. I know of no work on this topic that is not subject to similar negative comments. In my view though, the paper illustrates that economists are a long way from being able to give policy advice based on recent ideas. (Such a gap may well be a health steady state.)

Everything I have to say is at some level a variant of the famous Lucas Econometric Policy Evaluation Critique. I think this is to be expected. McKibbin and Sachs have undertaken policy evaluation using a data-based model, and this was precisely the setting for Lucas's critique. Most of the points Lucas made concerning modeling the first moments of agents' beliefs about a model's variables have been answered in the present simulation strategy, so I will take up a few other aspects of the critique.

Some Standard Caveats

Recall that the Lucas Critique is a criticism of the methodology of estimating parameters using data generated under one regime and taking these parameters as being necessarily invariant to policy-regime changes. Lucas's suggested research program to carry out econometric policy evaluation requires that deep structural parameters of tastes and technology be estimated. The hope is that such parameters will be invariant to policy-regime changes.

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McKibbin and Sachs have treated parameters such as adjustment speeds in money markets as policy-invariant. I would expect adjustment speeds to be chosen by agents as an optimal response to the economic environment. Parameters such as these may well change radically in response to the various monetary policies simulated in the paper. Therefore, I would have found helpful a report on the sensitivity of the simulations to policy-induced alterations in some of the parameters. An alternative might have been to design the simulated policies so that it can be argued that a policy shift would have little effect on the parameters.

In the appendix the parameterization of the model is given with the parameters treated as fixed numbers. Almost all of these numbers are actually random variables, some probably quite imprecisely estimated, some jointly distributed with other parameters, and some (almost surely) inconsistently estimated according to the model being simulated. I do not think anything can be done easily about these points. Some notion of the confidence intervals of the simulations would have been useful to me with those confidence intervals based on the joint distribution of the parameters. I also would have liked a section persuading me that a reasonable attempt had been made to secure parameter estimates consistent under the simulated model.

Social Welfare

The social welfare function adopted for the dynamic game simulation in section 3.5 is not necessarily consistent with the behavior in the rest on the model. Ideally, the social welfare function would be a policy invariant function of the utilities of the agents responsible for behavior in the rest of the model.

The specific social welfare function adopted in the paper makes the flow of social welfare a quadratic function of the output gap, CPI inflation, the current account as a percentage of GDP, and the budget deficit relative to GDP. The quadratic form implies that optimizing government policy minimizes a linear function of the second moments of these variables. Some assumption about the social welfare function must be made, but why is this a particularly interesting assumption? Some of the variables listed in the chosen function—for example, the current account and the government deficit relative to GDP—are measures of variables that adjust to buffer shocks and would not in general be zero at stochastic "bliss."

My guess is that McKibbin and Sachs adopted their social welfare function on the basis of their observations of statements made by representatives of OECD governments. My fear is that such statements are regime-specific and would be altered under precisely the conditions that would bring about the policy shifts being analyzed. If my view is

correct, then even the social welfare function (since it is not derived from deeper considerations) should not be viewed as policy-invariant.

What Do We Mean by Changes in Policy?

The methodology of rational expectations requires that agents have rational beliefs about the moments of variables relevant to their decisions. This presents a new problem for those trying to give policy advice. Under some other assumptions it is sensible to think about introducing a new policy or reviving some long-dormant policy with agents reacting to the policy shift as if it were a complete surprise and as if they thought the policy would never be abandoned. Rational expectations are somewhat more demanding of the would-be policy adviser.

Fully rational agents are rational about policy. They understand that government policy is altered from time to time as dictated by events. The realization of a particular policy is like the realization of any other random variable. When it happens it is a surprise, but it is not an entirely unforeseen surprise. Furthermore, when the policy is realized there is typically no reason for agents to believe that the current policy realization is the final policy realization.

Rational expectations, consequently, lead us to think about policy modeling in a very different way than we thought about it ten or fifteen years ago. Policy is the outcome of a (possibly optimizing) decision process, and policy is set and changed as the state variables relevant to the policy decision process evolve. Consequently, to give policy advice in a rational expectations environment, one must first discover what historical state of the system led to the choice of the current policy and then find out how the state has evolved since the most recent policy choice was made.

McKibbin and Sachs approach policy modeling in the traditional way—an econometric model is used to simulate the effects of new policies taking as fixed the nonpolicy economic environment in which the model was estimated. It seems to me that this approach is internally inconsistent. Why is new policy advice needed unless the economic environment has somehow changed? But if the economic environment has changed, the change should have been incorporated into the economic model.

Final Comments

As I mentioned at the beginning of my comments, the McKibbin and Sachs paper is state-of-the-art policy modeling. Although my comments were all negative, I do not want to give the impression that I know of any work on this topic that is not subject to similar negative comments.