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Macroeconomic Policy Coordination among the Industrial Economies

THE TURBULENT EVENTS in the world economy since 1973 have several times prompted the call for the major countries in the Organization for Economic Cooperation and Development (OECD) to coordinate their macroeconomic policies.¹ In the immediate aftermath of the 1973 oil

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1. For useful discussions of the policy coordination debate in the context of the economic summit meetings, see George de Menil and Anthony M. Solomon, *Economic Summitry* (New York: Council on Foreign Relations, 1983), and Robert D. Putnam and Nicholas Bayne, *Hanging Together: The Seven-Power Summits* (Harvard University Press, 1984). Michael Stewart, in *The Age of Interdependence: Economic Policy in a Shrinking World* (MIT Press, 1984), offers an interesting brief for greater policy coordination and discusses the historical experience in several chapters. For a view of the debate over policy coordination in 1983, see Sylvia Ostry, "The World Economy in 1983: Marking Time," *America and the World 1983*, special issue, *Foreign Affairs*, vol. 62, no. 3 (1984), pp. 533–60.

price shock, for example, the finance ministers of the main industrial countries made a commitment, only partly fulfilled, to avoid deflationary policies designed to pass current account deficits on to partner countries. Following the deep recession of 1974–75, the Carter administration urged in 1977–78 a “locomotive approach” for world recovery, in which the major economies were to act jointly to stimulate a world expansion. This policy was adopted by the heads of state at the 1978 Bonn summit conference. After the world recession of 1980–82, several policymakers and economists called for a joint world reflation, but in this case the U.S. administration stood firmly opposed to such a coordinated policy.² And recently, several economists have advocated that the European economies embrace more expansionary fiscal policies in return for reduced long-run U.S. deficits.³ The implication appears to be that while both the United States and Europe would benefit from such a swap in policy, neither side can or will undertake the prescribed policies independently.

Advocacy of international coordination has been far more plentiful than actual implementation. The 1978 Bonn summit is the principal example of a macroeconomic policy package adopted by the major economies. While there are few cases of successful policy coordination, advocates of coordination argue that there are many illustrations of the need for coordination. Individual economies have on several occasions tried to expand in the midst of a world contraction. The United Kingdom and Sweden tried to bridge the world recession of 1974, and while they succeeded in the short run in maintaining gross national product, the longer-run consequences were large balance of payments deficits, currency depreciation, and eventually a sharp policy reversal (in 1976 Britain actually required a stabilization loan from the International

2. A clear statement of the administration’s position may be found in Martin Feldstein, “The World Economy Today,” *The Economist*, June 11–17, 1983. He was responding to other writers in *The Economist* who had urged a coordinated global expansion; these writers and the dates their articles appeared were Helmut Schmidt (February 26–March 4, 1983), Valéry Giscard d’Estaing (May 21–27, 1983), and C. Fred Bergsten and Lawrence R. Klein (April 23–30, 1983). One of the most widely publicized calls for a coordinated reflation came in 1982 from a group of 26 economists from several countries in Institute for International Economics, “Promoting World Recovery: A Statement on Global Economic Strategy” (Washington, D.C.: IIE, 1982).

3. See Richard Layard and others, “Europe: The Case for Unsustainable Growth,” Discussion Paper (Brussels: Centre for European Policy Studies, Macroeconomic Policy Group, May 1984). Others in the Macroeconomic Policy Group participating in the study were Giorgio Basevi, Olivier Blanchard, Willem Buiter, and Rudiger Dornbusch.

Monetary Fund). As one Swede remarked, “We tried to build a bridge in 1974, but ended up with a pier instead.” Similar episodes include the U.S. expansion during 1976–78 and the Mitterrand policy in France in 1981. In all of these cases, external constraints played a significant role in limiting the benefits of expansion.

These cases suggest that unilateral expansionary policies may be difficult to sustain and costly in terms of inflation and foreign borrowing. Advocates of coordination point out that if *every* country fears unilateral expansion, then all can get stuck in a low-level equilibrium even if all would like to expand. But it is too facile to jump to the conclusion that absence of coordination explains much or most of the worldwide contraction in recent years. When West Germany stuck with contractionary policies in 1981 at the time of the French expansion, it was not merely a German fear of external imbalance that was to blame but also German fears of rekindling inflation through any demand stimulus at all, whether or not matched from abroad. Moreover, there are cases where countries have successfully expanded without a currency collapse, the most recent being the U.S. expansion since the fourth quarter of 1982. Perhaps it is the policy mix, as well as the overall policy stance, that determines whether a unilateral expansion is feasible.

In our view, the case for coordination must rest on the demonstration that all countries can benefit, in terms of their own policy goals, from a coordinated package of macroeconomic policies, and not on the mere fact that a unilateral expansion is painful. More precisely, the case for coordination must rest on the demonstration of a Pareto improvement in the economic outcome. If German-French cooperation in 1981 had raised output and inflation in both countries, it may well be true that France would have been better off relative to French goals, but could we guarantee the same for inflation-minded Germany?

Most formal exercises arguing for a global policy package miss this point. A demonstration that “global multipliers” are higher than “individual country” multipliers is not a proof of the Pareto improvement from a joint reflation.⁴ Similarly, a demonstration that a policy package

4. An example of a study comparing single-country and multicountry multipliers is Flemming Larsen, John Llewellyn, and Stephen Potter, “International Economic Linkages,” *OECD Economic Studies*, no. 1 (Autumn 1983), pp. 43–91. The multipliers are valuable for macroeconomic forecasting and are suggestive regarding the gains from coordination but are not in themselves a proof of the Pareto improvement from policy coordination.

has “nice outcomes” for several countries is also not sufficient. A widely publicized Project Link analysis of global reflation showed that West Germany, Japan, the United Kingdom, and the United States together could engineer a noninflationary recovery.⁵ But it did not show what each country could do on its own nor how much gain was to be had from coordination per se (in fact, in the Link model, some countries on their own can engineer a recovery with falling prices because some of the country models suppose that cyclical productivity gains in recovery are passed through to lower prices).

Our goal in this paper is to recast the arguments for coordination in terms that consider each country’s macroeconomic goals so that we may evaluate whether the major countries can each raise economic welfare through a joint policy action. In doing this we spell out the reasons to believe that uncoordinated policymaking across countries will indeed be inefficient (in the sense that Pareto improvements are possible); our reasoning about such policymaking follows the theoretical work of Hamada, Canzoneri and Gray, Johansen, Miller and Salmon, and Sachs.⁶ We then attempt to measure how large the gains to coordination are likely to be. For this purpose, we take two large-scale econometric models, the Japanese Economic Planning Agency (EPA) model and the Federal Reserve Board’s Multicountry model (MCM) as “true” models

5. The analysis was described by Bergsten and Klein in *The Economist*, April 23–30, 1983.

6. The pioneering studies in this area are by Koichi Hamada and include “Alternative Exchange Rate Systems and the Interdependence of Monetary Policies,” in Robert Z. Aliber, ed., *National Monetary Policies and the International Financial System* (University of Chicago Press, 1974), pp. 13–33, and “A Strategic Analysis of Monetary Interdependence,” *Journal of Political Economy*, vol. 84 (August 1976), pp. 677–99. Recent studies include Matthew E. Canzoneri and Jo Anna Gray, “Two Essays on Monetary Policy in an Interdependent World,” International Finance Discussion Paper 219 (Board of Governors of the Federal Reserve System, February 1983); Leif Johansen, “A Note on the Possibility of an International Equilibrium with Low Levels of Activity,” *Journal of International Economics*, vol. 13 (November 1982), pp. 257–65; M. Miller and M. Salmon, “Dynamic Games and the Time Inconsistency of Optimal Policies in Open Economies,” paper presented at the National Bureau of Economic Research Conference on the International Coordination of Economic Policy, August 1983; and Jeffrey Sachs, “International Policy Coordination in a Dynamic Macroeconomic Model,” Working Paper 1166 (National Bureau of Economic Research, July 1983). For a recent survey of theoretical issues, see Richard N. Cooper, “Economic Interdependence and Coordination of Economic Policies,” in R. Jones and Peter B. Kenen, eds. *Handbook of International Economics* (Amsterdam: North-Holland, forthcoming).

of the world and focus on policy coordination among the United States, West Germany, and Japan.

Our strategy for measuring the gains from coordination is to compare two equilibriums: one in which each country's macroeconomic authorities pursue optimal policies taking as given the actions abroad, and one in which the authorities bargain over a coordinated package of policies. The first type of equilibrium is referred to as a "Nash" or "noncooperative" equilibrium, and the second as a "cooperative" or "bargaining" equilibrium. We then ask how much each country's welfare (measured in units of GNP, as described later) is raised in moving from the noncooperative to cooperative equilibrium.

The gains from coordination in this sense are certainly present, but they appear to be modest, at least when the United States, Germany, and Japan are the only countries taking policy actions in response to the coordination. Perhaps the United States could gain the utility equivalent of one-half percentage point of GNP in each of the next few years from a more coordinated expansion; the West German gain is about the same, and the Japanese gain is somewhat higher. It does not appear that cooperation among the leading three economies could be the decisive factor in world recovery. We note later several qualifications to this conclusion. Most important, these estimates ignore any policy responses outside of the United States, Germany, and Japan that might arise from the coordinated decisions of these three large countries. For example, if German macroeconomic policy is matched throughout the European Community (EC), then the gains to coordination should be at least twice as large.

It should be stressed that our measures refer to only one type of gain from coordination. We abstract from many other possible gains that advocates of coordination often mention. We assume, for example, that policymakers know the "true" model of the world economy and have perfect knowledge of the actions taken in other countries. Thus, we abstract from the informational gains that might emerge from closer coordination of policies. Also, we abstract from the possible strengthening of political ties that might follow a closer harmonization of macroeconomic policies.

Though the major economies are richly linked in commodity and financial markets, the direct effects of commodity trade on macroeconomic interdependence remain surprisingly small; at the core, it is these

Table 1. Exports and Imports as Share of Country's GNP, 1982

Percent

Country	Trading partner						Total ^a
	United States	West Germany	Japan	European Community	Other industrialized countries	Rest of world	
<i>United States</i>							
Exports	...	0.3	0.7	1.6	1.6	3.1	7.0
Imports	...	0.4	1.3	1.4	1.9	3.5	8.1
<i>European Community</i>							
Exports	1.7	2.9	0.2	12.9	3.1	7.0	24.9
Imports	2.2	3.3	0.8	12.9	3.1	7.4	26.4
<i>Japan</i>							
Exports	3.4	0.5	...	1.6	1.1	6.8	13.0
Imports	2.3	0.2	...	0.7	1.4	7.9	12.3
<i>West Germany</i>							
Exports	1.8	...	0.3	12.8	4.6	7.2	26.6
Imports	1.8	...	0.8	11.2	3.2	6.3	23.4
<i>France</i>							
Exports	0.9	2.4	0.2	8.0	1.7	6.3	17.1
Imports	1.7	3.6	0.6	10.2	2.1	7.0	21.4
<i>United Kingdom</i>							
Exports	2.8	2.0	0.2	8.6	2.9	6.1	20.6
Imports	2.5	2.6	1.0	9.3	3.7	4.6	21.1

Source: Data on exports and imports are from International Monetary Fund, *Direction of Trade Statistics, Yearbook 1983* (IMF, 1983); data on GNP and exchange rates are from Organization for Economic Cooperation and Development, *OECD Economic Outlook*, no. 34 (Paris: OECD, 1983).

a. Components may not add to totals because of rounding.

relatively small trade links that condition our conclusions regarding the returns to coordination. Table 1 shows a merchandise trade matrix for major industrialized countries and the rest of the world. Incredibly, total U.S. merchandise exports to the EC amounted in 1982 to only 1.6 percent of U.S. GNP and 2.2 percent of EC GNP. Similarly, U.S. imports from the EC amounted to 1.4 percent of U.S. GNP and 1.7 percent of EC GNP. The simple fact is that although the European economies are highly open, fully one half of European trade remains within Europe, and of the rest, only about 15 percent is with the United States and 4

percent with Japan. With these trade links, the direct demand effects of U.S. stimulus on Germany or of Germany on the United States are naturally quite small. A 1 percent increase in U.S. import demand, leading to a 1 percent larger import volume from Germany, would have a direct effect of raising German GNP by 0.02 percent. In this case, indirect effects on German export sales of higher U.S. imports from the rest of Europe and elsewhere might triple or quadruple the demand effect, but it would still remain rather small. The effects of German purchases on the United States are likely to be far smaller. A 1 percent rise in German imports from the United States amounts to 0.003 percent of U.S. GNP.

Of course U.S. influences on the rest of the world are much more pronounced than such simple multiplier calculations suggest. The U.S. dollar remains the linchpin of the world monetary system. As shown in table 2, the currency of denomination of international reserves, Euro-dollar loans, new issues of Eurobonds, and OPEC portfolio wealth remains to a far higher extent in U.S. dollars than the U.S. share of world GNP would suggest. The special role of the dollar leads to important asymmetries between the effects of U.S. policies on Europe and Japan, and the effects of European and Japanese policies on the United States. Shifts in the value of the dollar can have significant income redistributive effects throughout the world that may also have important aggregate demand consequences; changes in the value of the European currencies or the Japanese yen do not have such effects.⁷ Also, by virtue of the dollar's role in world currency, it appears that the United States can run high budget and current account deficits without a major depreciation of the dollar, while in Europe and Japan, a similar level of budget and external deficits would probably cause a significant depreciation of the currency. Unfortunately, only some of these asymmetries are well captured by the macroeconomic models that we employ here.

The rest of the paper is divided into four sections. In the first we present a two-country macroeconomic model to trace the major channels for macroeconomic policy interdependence. The goal is to show how various structural characteristics determine the effects of one country's

7. Of most importance in recent years, the sharp appreciation of the U.S. dollar raised the real value of the less-developed countries' debts to international commercial banks and thereby contributed to the drop in LDC imports from the OECD area in the past two years.

Table 2. The Role of the U.S. Dollar in International Finance

<i>Measure</i>	<i>Percent in U.S. dollars</i>		
	<i>1975</i>	<i>1978</i>	<i>1981</i>
Official reserves ^a	79.4	76.9	70.6
Eurodollar loans ^b	73.7	67.6	70.6
Eurobond issues	47.2	48.2	80.2
OPEC reserves (1975–79)	n.a.	60.0	n.a.
<i>Addendum</i>			
U.S. share of world GNP	24.3	25.0	n.a.

Source: For official reserves, Eurodollar loans, and Eurobond issues, Peter B. Kenen, "The Role of the Dollar as an International Currency," Occasional Papers, 13 (New York: Group of 30, 1983), pp. 17, 25, 28; the estimate of OPEC reserves in dollars is from Organization for Economic Cooperation and Development, "Exchange Rates in Interlink" (Paris: OECD, September 1983), p. 27; the U.S. share of world GNP is from the World Bank *Atlas*, 1977 and 1980 editions.

n.a. Not available.

a. For all countries.

b. Foreign currency claims on nonresidents reported by European banks.

policies on another; these characteristics include the degree of international asset substitutability and the extent of wage indexation in each economy.

With these cross-country channels explained, we describe in the second section the logic of macroeconomic coordination. Two types of equilibriums are distinguished: an uncoordinated policy equilibrium, in which each country selects macroeconomic policies while taking the actions abroad as given; and a cooperative equilibrium, in which policies are a bargained outcome among the participating countries. We show that a cooperative equilibrium will in general allow all countries to reach a higher level of economic welfare.

In the third section of the paper, we use two large-scale econometric models to quantify the gains to a coordinated (or bargained) policy package relative to the uncoordinated policy settings. Three cases are examined here: the scope for coordination at the current macroeconomic juncture; the implications of a shift in U.S. policy toward fiscal restraint and monetary ease; and the role for coordination in the event of another major rise in oil prices.

In the final section of the paper we discuss some of the weaknesses of the analysis and some of the possible shortcomings of the macroeconomic models that we employ. We detail various ways in which we may have understated or overstated the benefits of policy coordination and point out some of the greatest uncertainties lurking in the parameters of the underlying models.

Macroeconomic Policy under Floating Exchange Rates

International linkages in commodity markets and financial markets substantially complicate the standard closed-economy analysis of macroeconomic policies. The effect of domestic policies on the domestic economy (“own-country” multipliers) depends crucially on the degree of capital mobility between the home country and the rest of the world and on the substitutability of home and foreign goods in aggregate demand. The price effects of various policies may be heavily affected by exchange rate movements in the wake of policy changes. A fiscal expansion, for example, may raise output while actually reducing inflation via an appreciation of the domestic exchange rate. To illustrate some of the possible effects of openness on policy effectiveness, we begin with a simple static model of two economies. Elsewhere we have studied dynamic perfect-foresight models of economies with the same essential structure described here, and the qualitative conclusions of the static model are the same as those of its more appropriate dynamic counterpart.⁸ In presenting the model we list only the behavioral equations for the home economy, with the understanding that comparable equations hold abroad (an asterisk denotes foreign variables).

The domestic economy produces an output Q at price P . Home output competes with foreign output Q^* at price P^* . The exchange rate E will measure units of the home currency per unit of foreign currency, so that increases in E imply a depreciation of the home currency. The real exchange rate for the home economy is $\Lambda = EP^*/P$, and demand for the home good relative to the foreign good will be a rising function of Λ .

Aggregate demand at home is the sum of private absorption, A (equal to consumption plus investment demand), government spending, G , and net exports, $X - \Lambda I$:

$$(1) \quad Q = A + G + X - \Lambda I.$$

Absorption is a function of output net of taxes, $Q - T$, the interest rate at home, i , and the private sector’s wealth, W . In particular, $A =$

8. See Jeffrey Sachs and Charles Wyplosz, “Real Exchange Rate Effects of Fiscal Policy,” Working Paper 1255 (National Bureau of Economic Research, January 1984), and Sachs and Wyplosz, “La Politique Budgétaire et le Taux de Change Réel,” in *Annales de L’INSEE*, vol. 53 (January–March 1984), pp. 63–91.

$(1 - s)(Q - T) - vi + \delta W$, where s is the marginal propensity to save out of current disposable income and δ is the marginal propensity to consume out of financial wealth. Real private wealth, W , is the sum of the real value of home bonds, B , and foreign bonds, B^* , held by the domestic private sector. Let $b = B/P$ and $b^* = B^*/P^*$. Then $W = B/P + EB^*/P = b + \Lambda b^*$.

Private absorption is divided between home goods, C^H , and imports, so that $A = C^H + \Lambda I^P$, where I^P is private-sector imports. In particular, $I^P = (\mu A)\Lambda^{-\rho}$, where μ is the marginal propensity to import out of total absorption and ρ is the real exchange rate elasticity of import demand. The government is assumed to import with a constant marginal propensity μ^G . Thus, $\Lambda I^G = \mu^G G$. The total value of imports is therefore $\Lambda(I^P + I^G)$, which equals $(\mu A)\Lambda^{1-\rho} + \mu^G G$. Similarly, exports, X , equal $(\mu^* A^*)\Lambda^{\rho^*} + \mu^{G^*} \Lambda G^*$.

Next, we turn to aggregate supply and price level determination. The consumer price level, P_c , is a geometrically weighted average of home and foreign goods prices, with $P_c = P^\kappa (P^* E)^{(1-\kappa)}$. Denoting the logarithms of upper-case price variables by lower-case variables, we have:

$$(2) \quad p_c = \kappa p + (1 - \kappa)(e + p^*).$$

Note as well that p_c may be written as $p_c = p + (1 - \kappa)\lambda$, where $\lambda = \log(\Lambda)$. Thus, a real-exchange-rate depreciation raises consumer prices at a given level of domestic prices. The (log) wage is a function of the consumer price level and the output level:

$$(3) \quad w = \alpha p_c + \gamma Q.$$

Domestic prices are taken to be a fixed markup over domestic wages, so that

$$(4) \quad p = w.$$

The model is completed by specifying the asset market equilibrium conditions. First, demand for (log) real money balances $m - p$ is a function of output and nominal interest rates in a standard equation for the transactions demand for money:

$$(5) \quad m - p = \varphi Q - \beta i.$$

The bond market equilibrium conditions are particularly important for the workings of fiscal policy. Home and foreign wealth holders divide

their portfolios between home and foreign bonds based on relative rates of return of the two assets. For simplicity we assume that wealth holders at home and abroad have identical portfolio preferences and thus divide their wealth between home and foreign bonds in proportions ϑ and $(1 - \vartheta)$ with an adjustment according to relative rates of return. With static expectations the rates of return differ by $i - i^*$, and world demand for the home asset is written as

$$(6) \quad b^T = \vartheta(W + \Lambda W^*) + \sigma(i - i^*).$$

Here, b^T is the real total government debt outstanding, which is divided between home, b , and foreign holdings, b^f , and σ is the degree of asset substitutability. A crucial asymmetry between the United States and all other countries in the world involves the parameter ϑ . The U.S. dollar is the preeminent international asset, and we have cited evidence to show that this preeminent role has remained despite the declining U.S. share of the world real economy. The presumption therefore is that $\vartheta^{US} \gg \vartheta^{OECD}$, where ϑ^{OECD} is the marginal propensity to hold wealth in the currencies of the other OECD economies. We shall see shortly that the size of ϑ has strong implications for the impact of fiscal policy.

In a dynamic model, the supply of bonds b^T would equal the cumulation of government deficits through time, net of changes in central bank holdings of the public debt. In this static model, we simply assume that initial outstanding debt is zero, so that b^T equals $G - T$, the contemporaneous government deficit. Similarly, household wealth would equal the cumulation of private savings, adjusted for capital gains and losses. Here, we set W equal to contemporaneous private saving $Q - T - A$ (see the Sachs and Wyplosz papers cited in note 8 for the corresponding equations in a dynamic setting). Note that under our assumptions, $W + \Lambda W^*$ equals $(Q - T - A) + \Lambda(Q^* - T^* - A^*)$, which in turn equals $b^T + \Lambda b^{*T}$.

The full model is shown in table 3 (with only home-country equations). The trade equations and the bond market equilibrium condition have been linearized around an initial equilibrium of $\lambda = 0$ (that is, $\Lambda = 1$) and $b^{*T} = 0$. The import demand equation $I = (\mu A)\Lambda^{-\rho} + \mu^G G/\Lambda$ becomes $I = -(\rho\mu A_0 + \mu^G G_0)\lambda + \mu A + \mu^G G$. The export demand equation $X = (\mu^* A^*)\Lambda^{\rho^*} + \mu^{G^*} \Lambda G^*$ becomes $X = (\rho^* \mu^* A_0^* + \mu^{G^*} G_0^*)\lambda + \mu^* A^* + \mu^{G^*} G^*$. Last, the trade balance $X - \Lambda I$ becomes $TB =$

Table 3. The Two-Country Model

Equations ^a			
<i>Demand</i>			
Aggregate demand	$Q = A + G + NX$		
Net exports	$NX = X - \Lambda I$		
Absorption	$A = (1-s)(Q-T) - vi + \delta W$		
Real private wealth	$W = Q - T - A$		
Export demand	$X = (\rho^* \mu^* A_0^* + \mu^{G^*} G_0^*) \lambda + \mu^* A^* + \mu^{G^*} G^*$		
Import demand	$I = -(\rho \mu A_0 + \mu^G G_0) \lambda + \mu A + \mu^G G$		
<i>Prices</i>			
Real exchange rate	$\lambda = p^* + e - p$		
Price level (home good)	$p = w$		
Wage level	$w = \alpha p_c + \gamma Q$		
Consumer price level	$p_c = \kappa p + (1-\kappa)(p^* + e)$		
<i>Asset markets</i>			
Money demand	$m - p = \varphi Q - \beta i$		
Domestic bond supply	$b^T = G - T$		
Bond market equilibrium	$i - i^* = [(1-\delta)b^T - \delta b^{*T}]/(1/\sigma)$		
Definitions ^a			
A	Absorption of the private sector	p	log (Home price)
b^T	Stock of domestic bonds	p_c	log (Consumer price)
e	log (Nominal exchange rate)	Q	Output
G	Fiscal expenditure in home goods units	T	Taxes
I	Import demand	W	Real wealth
i	Interest rate	w	log (Nominal wage)
m	log (Money demand)	X	Export demand
NX	Net exports in home goods units	Λ	Real exchange rate
		λ	log (Real exchange rate)

a. Equations apply to the home country. Asterisks denote foreign-country variables. Symmetric equations apply to the foreign country.

$[\rho^* \mu^* A_0^* + \mu^{G^*} G_0^* - (1 - \rho) \mu A_0] \lambda + (\mu^* A^* - \mu A) + (\mu^{G^*} G^* - \mu^G G)$. The term $[\rho^* \mu^* A_0^* + \mu^{G^*} G_0^* - (1 - \rho) \mu A_0]$ is the partial effect of λ on TB and is hereafter denoted ϵ . For $\mu^* A_0^* = \mu A_0$ and $G_0^* = 0$, the term is positive if and only if $\rho + \rho^* > 1$, which is the traditional Marshall-Lerner condition for the effectiveness of a devaluation. Most empirical studies suggest that $\partial TB / \partial \lambda$ is negative over a short horizon (six months) following a devaluation but is positive afterward as trade volumes adjust to relative price changes. We ignore this so-called J-curve effect and hereafter assume $\epsilon > 0$.⁹

9. In the EPA model and the MCM, which we use later in the paper, the J-curve effect is typically eliminated in one to three quarters, and in spite of a current account worsening on impact, an exchange rate depreciation is typically expansionary on impact.

Table 4. Policy Multipliers in the Two-Country Model^a

	Monetary policy						Fiscal policy					
	$\frac{dQ}{dm}$	$\frac{d\lambda}{dm}$	$\frac{dp_c}{dm}$	$\frac{dQ^*}{dm}$	$\frac{dp_c^*}{dm}$	$\frac{dNX}{dm}$	$\frac{dQ}{dG}$	$\frac{d\lambda}{dG}$	$\frac{dp_c}{dG}$	$\frac{dQ^*}{dG}$	$\frac{dp_c^*}{dG}$	$\frac{dNX}{dG}$
<i>Fixed prices^b</i>												
$\sigma = 0$	+	+	+	-	-	+	+	+	+	-	-	+
$\sigma = \infty$	+	+	+	-	-	+	+	-	-	+	+	-
<i>Foreign indexation^c</i>												
$\sigma = 0$	+	+	+	+	\pm	+	+	+	+	+	\pm	+
$\sigma = \infty$	+	+	+	+	\pm	+	+	\pm	\pm	\pm	\pm	\pm
<i>Domestic indexation^d</i>												
$\sigma = 0$	0	0	1	0	0	0	-	+	\pm	-	-	+
$\sigma = \infty$	0	0	1	0	0	0	+	-	\pm	+	+	-

Source: Derived from equations in the text; detailed calculations available from the authors.

a. See definitions of variables in table 3 and equation 3; σ denotes asset substitutability.

b. $\alpha = \alpha^* = \gamma = \gamma^* = 0$.

c. $\alpha = \gamma = 0$; $\alpha^* = 1$, $\gamma^* > 0$.

d. $\alpha^* = \gamma^* = 0$; $\alpha = 1$, $\gamma > 0$.

The short-run effects of a bond-financed fiscal expansion ($dG > 0$, $dT = 0$) and a monetary expansion ($dm > 0$) are shown in table 4. For each set of policies, three cases are compared. First, we have the standard Mundell-Fleming assumptions of fixed prices (that is, no contemporaneous indexing) with perfect or zero asset substitutability. Second, we assume full foreign indexation ($\alpha^* = 1$, $\gamma^* > 0$) but still maintain fixed prices domestically. Third, we consider the inverse case of full domestic indexation and fixed foreign prices.

Monetary expansion is the easiest policy to consider. For $\alpha < 1$, output and consumer prices necessarily rise. The nominal and real exchange rate depreciate. The well-known lesson with regard to indexation is that a rise in indexation (higher α) reduces the output gain and increases the price consequences of the monetary expansion. In the extreme case where $\alpha = 1$, the monetary expansion raises prices and the nominal exchange rate in equiproportion (keeping the real exchange rate constant) and has no effect on the output level at home or abroad. In effect, constant real wages prevent a depreciation of the home real exchange rate.

For the foreign country, the degree of wage indexation α^* is crucial to the effects of a rise in m . In the Mundell-Fleming model, with $\alpha^* = 0$, a home monetary expansion reduces foreign income and foreign prices.

This is the traditional beggar-thy-neighbor interpretation of flexible exchange rates. The home expansion causes the domestic exchange rate to depreciate, shifting demand from foreign to domestic goods. Foreign demand drops and output falls. At the same time, the home depreciation reduces the other country's import prices, and thus the foreign consumer price index. In summary, $dQ^*/dm < 0$ and $dp_c^*/dm < 0$. In this view, tight monetary policies in the United States should be expected to raise European output and prices via the appreciation of the dollar.

Once we allow the foreign CPI to feed back into w^* and p^* , the simplicity of the first story is lost; now, a home monetary expansion helps to slow foreign wage and price inflation via the change in currency values, and the *real* depreciation of the home currency is diminished. With prices fixed, a change in e changes $p^* + e - p$ in equal amount. With foreign wage indexing, however, a rise in e now causes p^* to fall, so that the foreign country's competitive loss (which is measured by the rise in $p^* + e - p$) is diminished. Meanwhile, the foreign country enjoys the expansionary demand effects of lower world interest rates brought about by the home monetary expansion. Formal analysis leads to the following conclusions in the static model. When α^* is low, $dQ^*/dm < 0$; when α^* is near 1.0, $dQ^*/dm > 0$. In fact there exists a threshold degree of indexing, $\hat{\alpha}^*$, such that $dQ^*/dm > 0$ if and only if $\alpha^* > \hat{\alpha}^*$. Moreover, if γ^* is small, then for all α^* , $dp_c^*/dm < 0$. Thus, with very high wage indexation in Europe, a restrictive U.S. monetary policy might actually raise prices and lower output abroad and thus be a stagflationary shock.

Fiscal policy effects are more subtle than monetary policy effects, since the degree of asset substitutability now plays an important role. When $\sigma = \infty$, then the own-country effects of a fiscal expansion are to raise output and appreciate the currency. Prices may rise or fall, since on the one hand higher output tends to raise prices in the amount γdQ , while on the other hand currency appreciation reduces import prices and the CPI. With indexation, the reduction in import prices feeds through to domestic wages and prices.

The effect on foreign output and prices is ambiguous, depending heavily on the extent of foreign wage indexation. When $\alpha^* = 0$, as in the traditional Mundell-Fleming model, then $dQ^*/dG > 0$, and $dp_c^*/dG > 0$: the domestic expansion raises foreign output and prices. The reason is straightforward. The home currency appreciation causes aggregate demand to shift toward the foreign good. The expansion "spills over"

to foreign output. Foreign prices rise for two reasons: the direct effect of Q^* and the impact of the domestic appreciation on the foreign country's import prices. When α^* is large, it might well be that $dQ^*/dG < 0$. Without indexing, the domestic nominal appreciation causes a real appreciation, and a shift in demand abroad. With indexing, the nominal appreciation causes foreign wages to rise when import prices increase. As e falls, p^* rises, so that $p^* + e - p$ changes little. Thus, the rise in G does not cause as much (or any) real exchange rate appreciation, and demand does not shift to the foreign country. Meanwhile, higher G raises world interest rates, depressing foreign demand. On balance, if the contractionary interest rate effect is dominant, $dQ^*/dG < 0$. Since p_c^* will tend to rise because of the home nominal exchange rate appreciation, we may see $dQ^*/dG < 0$ and $dp_c^*/dG > 0$. In this case, a U.S. fiscal expansion would be a stagflationary shock to the European economies.

Once we allow for imperfect asset substitutability, most of these effects can be reversed. A fiscal expansion causes the risk premium on home assets to rise because the increase in b^T relative to b^{*T} leads to an ex ante excess supply of domestic bonds. The partial effect of a rise in b^T is twofold. As portfolio holders attempt to shift from domestic to foreign assets at the initial levels of the exchange rate and interest rates, domestic bond prices are driven down and foreign bond prices are driven up, so that $i - i^*$ rises. Also, the shift toward foreign bonds causes the exchange rate to depreciate, which helps restore portfolio equilibrium for two reasons. First, the domestic depreciation reduces the share of portfolio wealth devoted to home assets (which were initially in excess supply); second, the depreciation raises the expectation of a future appreciation of the home currency, increasing the demand for the home asset.

These partial effects of the portfolio shift can be added to the effects of fiscal policy under perfect asset substitutability to find the overall effect of a fiscal expansion when $\sigma < \infty$. On the one hand, the fiscal expansion raises demand for home goods and thereby tends to cause an appreciation; on the other hand, the rise in b^T causes i to rise, reduces the demand effect, and tends to cause a depreciation. In fact, the sum of the effects is ambiguous. The greater is σ , the more likely is an output expansion and currency appreciation; the smaller is σ , the more likely is a contraction (due to rising interest rates) and a currency depreciation (due to the excess supply in portfolio wealth of b^T , and the consequent

shift in foreign bonds). The depreciation and contraction do not necessarily go hand in hand. For reasonable parameter values, the fiscal expansion can raise output while simultaneously inducing a depreciation.

The slope of the LM curve (ϕ/β) is another determinant of the exchange rate effect of fiscal expansion. When ϕ/β is large (that is, the LM curve is steep), the fiscal expansion necessitates a large rise in i in order to equate money supply and demand at the initial exchange rate. The large increase in i needed to clear the money market contributes to an excess demand for home bonds, which tends to cause a capital inflow and exchange rate appreciation.

The implications of low σ for cross-country multipliers are similarly ambiguous. When α^* is very low (so that nominal wages are rigid), the absence of high capital mobility can make dQ^*/dG turn negative. With low σ , the home currency depreciates, and demand no longer spills over to the other country. Although foreign interest rates fall, because of the portfolio shift towards b^{*T} , the expansionary effects of the decline in i^* are smaller than the demand effects of the home country depreciation. When α^* is high (so that real wages are rigid), then the home country's nominal depreciation does not have much effect on the real exchange rate. As e rises, p^* falls, so that $p^* + e - p$ remains substantially unchanged. Then, the foreign country does not lose much in external competitiveness, but it gains by the reduction in interest rates. In this case, dQ^*/dG is more likely to be positive.

It is important to note that the higher is the world's marginal propensity to hold domestic bonds out of wealth (ϑ), the more likely is a currency appreciation following a fiscal expansion. At initial interest rates and exchange rate, a rise in b causes supply of home bonds to rise by b and demand to rise by ϑb . Thus, the excess supply of home bonds is $(1 - \vartheta)b$, and the interest rate differential, $i - i^*$, must rise by $(1/\sigma)(1 - \vartheta)b$. Evidently, the larger is ϑ , the smaller is the necessary increase in the interest rate differential, and the more likely is a currency appreciation following a fiscal expansion. The fact that ϑ is large for the United States and small for all other major currencies is an important factor in explaining why a U.S. fiscal expansion tends to strengthen the dollar while a similar expansion in France, West Germany, Japan, or the United Kingdom is perceived to weaken the currency. We return to this point in the empirical evidence below.

SOME LONG-RUN EFFECTS OF MACROECONOMIC POLICIES

Long-run effects of monetary and fiscal policy may differ substantially from the short-run effects. First, in the long run, prices adjust to restore full employment, so that all long-run demand effects of m , G , and T show in prices rather than output. But less obvious, permanent changes in G and T lead to long-run changes in the economy's net international investment position, and therefore in the long-run real exchange rate. Interestingly, these long-run effects can move in the direction opposite to that of the short-run effects.

To discuss this issue, we must be clear on the meaning of "long-run" policies. First, we redefine b^T , G , and T to be in units per potential GNP, which is assumed to grow at the exogenous rate n . The evolution of public debt now is governed by $b_{t+1}^T = (1 + r - n)b_t^T + (G - T)$. Assuming that real interest rates, r , exceed an economy's trend growth rate, n , then a permanent rise in G for given T is not feasible. If G is raised permanently above T_0 (with $b_0^T = 0$), then b^T would grow without bound. Eventually government debt servicing alone would exceed national product. The government's long-run budget constraint requires that b^T remain bounded. One feasible policy, which we study here, is a choice of G_t and T_t such that the deficit relative to potential GNP remains constant at some level.

A fixed deficit, $G + rb^T - T$, leads to a steady-state debt/GNP ratio of $(1/n)(G + rb^T - T)$. For an economy growing at 3 percent per year, for example, a permanent rise in the deficit of 1 percent of GNP (for given r) leads to a steady-state increase of b^T of $(0.01/0.03) = 1/3$ (for example, a rise in the debt/GNP ratio from 0.0 to 0.33). Of course, many combinations of G and T can stabilize the deficit at a particular level. The policy that we study is one in which G is permanently raised at time zero by dG , and taxes are thereafter adjusted in line with rising debt servicing so that the overall deficit relative to GNP remains permanently higher by the amount dG . Moreover, to keep the story simple, we assume that the real interest rate is fixed (for example, determined from abroad). (A rise in r after the fiscal expansion would merely amplify the results that we find below.) Then the change in taxes, dT , follows the path of changing debt, db^T :

$$(7) \quad dT_t = rdb_t^T.$$

When G rises, taxes are initially unchanged. As debt accumulates, taxes are raised to service the increased debt payments. Long-run debt obligations rise in the amount $(1/n)dG$, so that in the long run taxes rise in the amount r/n . Assuming, as we do, that $r > n$, then $dT/dG = r/n > 1$. Eventually, taxes rise by more than dG , even though the government deficit is maintained forever. It is easy to show that private-sector financial wealth falls, in the steady state, as follows.¹⁰

$$(8) \quad dW = - [(sr/n)/(\delta - r + n)]dG < 0.$$

The rest of the world ends up holding the entire increase in national government debt, and then some, since private-sector holdings of debt actually drop. In the long run, the home economy must run trade surpluses to service this increase in debt held abroad.

Because of the rise in taxes and the fall in wealth, private spending A falls by more than the rise in G :¹¹

$$(9) \quad dA = [(r/n)/(\delta - r + n)][(\delta - r + n) + s(r - n)](-dG) < -dG.$$

The rise in G raises aggregate demand for the home good in the amount $(1 - \mu^G)dG$. On the other hand, domestic private spending on home goods falls by $(1 - \mu)dA$. The real exchange rate must depreciate in the long run to raise demand for home goods as long as $[(1 - \mu)dA + (1 - \mu^G)dG]$ is negative. More precisely,

$$(10) \quad d\lambda = - (1/\epsilon)[(1 - \mu)dA + (1 - \mu^G)dG].$$

For $\mu \approx \mu^G$, there is a long-run real depreciation, while for $\mu \gg \mu^G$, λ will appreciate.¹²

10. $A = (1 - s)(Q - T) - vr + \delta W$, and $W = (1 + r - n)W + Q - T - A$. With Q and r fixed, we can solve for dW as a function of dT : $dW = - [s/(\delta - r + n)] dT$. Since $dT = (r/n)dG$, we arrive at equation 8 in the text.

11. Since $A = (1 - s)(Q - T) - vr + \delta W$, $dA = -(1 - s)dT + \delta dW$. Now substitute $dT = (r/n)dG$ and equation 8 to arrive at equation 9.

12. The fiscal expansion has two effects: reducing aggregate domestic absorption and shifting the structure of absorption between home and foreign goods. The fall in A tends to cause a long-run depreciation. A shift in the structure of absorption toward the home good tends to cause an appreciation. When $\mu = \mu^G$, only the absorption effect is operative, because the marginal propensities to import of the private and public sectors are equal. Therefore, when $\mu = \mu^G$, there must be a long-run depreciation. For $\mu > \mu^G$ there may be an appreciation, because the fiscal expansion serves to shift demand toward home goods. See Sachs and Wyplosz, "Real Exchange Rate Effects."

In this context, then, consider the effects of sustaining the U.S. budget deficits for a prolonged period into the future, holding the deficit/GNP ratio constant, and taking the optimistic case that real interest rates remain constant. As interest payments on the debt mount, taxes will have to be raised merely to service the debt. As taxes rise, domestic absorption will fall, and eventually the fall in A must exceed the rise in G . As long as $\mu \approx \mu^G$, the net effect of falling A and rising G will be an excess supply of U.S. goods. A real exchange rate depreciation will then be necessary to maintain demand equal to output. Thus, while the fiscal expansion appreciates the dollar in the short run, it depreciates the dollar in the long run.

EVIDENCE ON POLICY MULTIPLIERS IN THE UNITED STATES,
WEST GERMANY, AND JAPAN

We have seen that the magnitude of effects of monetary and fiscal policies on home and foreign variables depends on several parameters such as those measuring the degree of asset substitutability, the wage responsiveness to price changes, and the interest elasticity of money demand. It is beyond our capacity in this paper to provide independent evidence on each of these variables. Instead we rely heavily on the evidence contained in several large-scale multicountry models. The major conclusions from this evidence are as follows: (1) monetary expansion causes a much larger depreciation of the currency than does fiscal expansion per unit of GNP increase; (2) the United States is the only large country that shows a systematic tendency toward currency appreciation following a bond-financed fiscal expansion; (3) fiscal expansion has a smaller effect on prices than does monetary expansion per unit of GNP increase as a result of their differential impact on the exchange rate; and (4) fiscal expansion has a larger effect on current account deficits than does monetary expansion per unit of GNP increase, also as a result of the differential effects on the exchange rate.

The normalized own- and cross-country multipliers for monetary and fiscal policy are shown in table 5 (for the MCM) and table 6 (for the EPA model). The policies are scaled to produce one unit of GNP increase in the expanding country. The multipliers are measured as averages for a two-year period: GNP is measured as a percentage deviation from the baseline; inflation is the percentage-point increase relative to baseline;

Table 5. Normalized Policy Multipliers for Output, Inflation, and the Current Account Ratio, Multicountry Model^a

Country acting, and policy	United States			Japan			West Germany		
	Size of policy	Inflation rate	Current account ratio	GNP	Inflation rate	Current account ratio	GNP	Inflation rate	Current account ratio
<i>United States</i>									
Monetary	3.64	0.18	-0.02	1.00	0.00	0.07	-0.18	-0.18	0.02
Fiscal	0.83	0.12	-0.40	1.00	0.17	0.02	0.29	0.04	0.04
<i>Japan</i>									
Monetary	2.67	0.00	0.03	1.00	0.13	-0.11	-0.07	-0.07	0.00
Fiscal	0.71	0.00	0.03	1.00	0.11	-0.09	0.01	0.00	0.01
<i>West Germany</i>									
Monetary	4.44	0.00	-0.02	1.00	0.11	0.00	1.00	0.44	-0.04
Fiscal	1.03	0.10	0.04	1.00	0.05	0.03	1.00	0.22	-0.54

Source: Board of Governors of the Federal Reserve System, Division of International Studies, "FRB Multicountry Model, Version of August 1983" (FRB, 1983).

a. The table gives multipliers averaged over two years. Monetary policy is measured by the percentage-point decrease of the discount rate. Fiscal policy is measured by the increase of government spending as a percentage of GNP. The policies are normalized so as to produce 1 percent of GNP increase in the expanding country. GNP is measured as a percentage deviation from a baseline; the inflation rate is measured as a percentage-point deviation from a baseline; and the current account ratio (current account balance as a percent of GNP) is an absolute deviation from a baseline.

Table 6. Normalized Policy Multipliers for Output, Inflation, and the Current Account Ratio, Economic Planning Agency Model^a

Country acting, and policy	United States			Japan			West Germany			
	Size of policy	GNP	Inflation rate	Current account ratio	GNP	Inflation rate	Current account ratio	GNP	Inflation rate	Current account ratio
<i>United States</i>										
Monetary	4.08	1.00	0.09	-0.08	0.02	-0.22	0.06	-0.54	0.20	0.01
Fiscal	0.48	1.00	0.04	-0.16	0.14	0.00	0.04	0.27	0.05	0.06
<i>Japan</i>										
Monetary	2.50	-0.11	0.00	0.00	1.00	0.59	-0.02	-0.06	0.00	-0.02
Fiscal	0.64	0.00	0.01	0.01	1.00	0.18	-0.13	0.01	0.00	0.00
<i>West Germany</i>										
Monetary	1.11	-0.01	-0.01	-0.01	0.01	0.00	0.00	1.00	0.43	-0.05
Fiscal	0.51	0.01	0.00	0.00	0.09	0.03	0.02	1.00	0.14	-0.28

Source: Economic Planning Agency of Japan, Economic Research Unit, "The Results of Exchange Rate Simulations" (EPA, 1983). This study was prepared for the 1983 Link International Conference, September 12-16, 1983. The document points out that the model is being revised, and the results must be regarded as tentative.

a. See table 5, note a.

and the current-account/GNP ratio (current account ratio) is measured as an absolute difference from the baseline. The monetary policy is a percentage-point reduction in the central bank discount rate, and the fiscal policy is an increase of 1 percent of GNP in fiscal expenditures on goods and services. For the fiscal expansion, the monetary stance is characterized by an unchanged money base. In table 5, for example, we see that a 3.64 percentage point cut in the U.S. discount rate, sustained for two years, is estimated to raise U.S. GNP by 1 percent, raise U.S. inflation by 0.18 percentage points, and lower the U.S. current account share of GNP by 0.02 percent, all averaged over two years.

Examining first the own-country effects of monetary policy, we see that monetary policy is more inflationary than fiscal policy, and with only one exception (Japan, in the MCM), fiscal policy has a considerably larger effect on external deficits than does monetary policy. The models also all show that a monetary expansion causes a current account deficit. This finding will prove important in our discussion of policy coordination.

These differing effects of M (monetary policy) and G (fiscal policy) work in large part through the exchange rate. The normalized exchange rate multipliers for the MCM and the EPA and OECD Interlink models are shown in table 7. In every case, a monetary expansion causes a larger depreciation than does a fiscal expansion. The United States stands out as the only country with a tendency toward appreciation following a fiscal expansion. According to descriptions of the models, this asymmetry has two causes, and they are in line with our earlier discussion. First, all of the models incorporate an asymmetry in portfolio composition that gives a high marginal propensity to hold U.S. dollars out of financial wealth. Second, the econometric estimates of the monetary system all find a more steeply sloped LM curve (that is, a lower interest elasticity of money demand) in the United States than elsewhere. We saw earlier that an inelastic demand for money favors a currency appreciation following a fiscal expansion.

The differential impact of M and G on inflation (π) and the current account ratio (CA) suggests how different mixes of policy can achieve various targets among output (Q), inflation, and external balance. Suppose that $Q = M + G$, $\pi = m_1M + g_1G$, and $CA = m_2M + g_2G$, with $m_1 > g_1 > 0$, and $g_2 < m_2 < 0$. If the goal is to change inflation by $\Delta\pi < 0$ without reducing output, it can be brought about by a fiscal expansion and monetary contraction, such that

Table 7. Normalized Policy Multipliers for the Exchange Rate in the Economic Planning Agency, Multicountry, and Interlink Models^a

Country acting, and policy	Economic Planning Agency model		Multicountry model		Interlink model	
	Size of policy	Exchange rate effect	Size of policy	Exchange rate effect	Size of policy	Exchange rate effect
<i>United States</i>						
Monetary	4.08	-1.84	3.64	-1.91	8.00	-4.80
Fiscal	0.48	-0.02	0.83	0.49	0.64	0.29
<i>Japan</i>						
Monetary	2.50	-6.82	2.67	-1.07	6.67	-5.00
Fiscal	0.64	-1.63	0.71	-0.45	0.59	-0.15
<i>West Germany</i>						
Monetary	1.11	-2.82	4.44	-4.00	4.00	-3.30
Fiscal	0.51	-1.42	1.03	-1.17	0.80	-0.02

Source: A. Amano, "Exchange Rate Simulations: A Comparative Study," *European Economic Review* (forthcoming).

a. See table 5, note a. For Japan and Germany, the exchange rate is dollars per unit of national currency; for the United States, it is the trade-weighted effective exchange rate. A negative sign indicates a depreciation.

$$(11) \quad \begin{aligned} \Delta M &= \Delta\pi/(m_1 - g_1) < 0 \\ \Delta G &= -\Delta M > 0. \end{aligned}$$

If the goal is to improve the trade balance without a loss of output, then there should be a monetary expansion with fiscal contraction:

$$(12) \quad \begin{aligned} \Delta M &= \Delta CA/(m_2 - g_2) > 0 \\ \Delta G &= -\Delta M < 0. \end{aligned}$$

This simple illustration suggests that the Reagan administration's mix of expansionary fiscal policy and contractionary monetary policy, from the U.S. viewpoint alone, may make sense if the principal targets are output growth and reduced inflation, rather than output growth with current account balance.

Several systematic conclusions emerge from the cross-country multipliers. In both the MCM and the EPA model, the short-run wage responsiveness is too low to reverse the Mundell-Fleming conclusion that fiscal policy is positively transmitted. Similarly, the cross-country effect of monetary policy is negative (as in the Mundell-Fleming model) or, if positive, generally quite small. In all cases, a foreign fiscal expansion improves the home current account and raises (or leaves unchanged) domestic prices. The implied price rise per unit of GNP increase is

smaller than occurs with a domestic expansion because the exchange rate consequences are generally better if the other country engineers the expansion.

The other point about the multipliers is that while the United States has some effect on West Germany and Japan, the reverse effects are somewhat smaller in view of the relative sizes of the economies. Naturally, this will make it harder to interest the United States in a coordinated policy program, as the following section shows.

The Coordination of Macroeconomic Policies

In the absence of competitive markets, there is no reason to expect that individuals will fully exploit their gains from trade. This conclusion is most striking and obvious in the case of pure externalities, where the failure of a market to exist leads to overproduction of social harms (such as pollution) or underproduction of social goods. It is not surprising, therefore, that in the realm of macroeconomic policymaking, where no markets for policies exist, there may be unexploited opportunities for countries to “trade” macroeconomic policies that could leave all countries closer to their macroeconomic targets. The goal of this section is to discover what it is that countries can offer each other in “package deals” that swap macroeconomic policies.

Before turning to that question, we should note an unavoidable limitation to our analysis. Once it is recognized that countries have policy actions that can be offered to others in exchange for policy moves from abroad, there is really no reason for assuming that macroeconomic policies must be swapped only for macroeconomic policies, as opposed, for example, to trade or security concessions. The possibility of negotiating a package of international moves and agreements across a variety of fields is beyond our scope. Our focus here is on the gains from cooperation purely within the macroeconomic realm.

We use the classic Tinbergen targets-and-instruments framework, as adapted to a multicountry environment by Niehans, Cooper, and especially Hamada.¹³ Recent work in this area includes Johansen, Canzoneri

13. Jürg Niehans, “Monetary and Fiscal Policies in Open Economies under Fixed Exchange Rates: An Optimizing Approach,” *Journal of Political Economy*, vol. 76, part 2 (July/August 1968), pp. 893–920; Richard N. Cooper, “Macroeconomic Policy Adjust-

and Gray, Miller and Salmon, and Sachs (see note 6). Consider an n -country world economy, where each of the n countries has m policy targets. For country i , call the vector of targets T^i , which equals the m -tuple $(T^i_1, T^i_2, \dots, T^i_m)$. The country has l controls (policy instruments), with the vector of controls $C^i = (C^i_1, C^i_2, \dots, C^i_l)$. The macro-authorities choose C^i in order to maximize a welfare function $U^i(T^i)$.

In an interdependent world, each country's T^i will be a function of the control settings in *all* of the countries, and of a set of exogenous variables L :

$$(13) \quad T^i = F^i(C^1, C^2, \dots, C^n, L).$$

In a dynamic setting, T^i will also be a function of the "inherited conditions" of the world economy in any period, defined by a state vector S :

$$(14) \quad T^i = F^i(C^1, C^2, \dots, C^n, S, L).$$

In this case, policymakers will also have to take into account the effects of their actions today on future values of S . (In dynamic rational expectations models, T^i will also be a function of anticipated levels of C and L in the future.)

To formalize the idea of unexploited gains from trade, we describe uncoordinated policymaking as a situation in which each country chooses its policy instruments while taking as given the actions selected in the other $n - 1$ countries. Thus, in this case, no attempt is made to trade off an action at home for an action abroad, because all of the actions abroad are assumed to be given. This so-called Nash equilibrium is formalized as follows. A Nash equilibrium is an n -tuple $(C^{1N}, C^{2N}, \dots, C^{nN})$ such that for all countries i , C^{iN} maximizes $U^i(T^i)$ with respect to C^i , given that

$$T^i = F^i(C^{1N}, C^{2N}, \dots, C^{(i-1)N}, C^i, C^{(i+1)N}, \dots, C^{nN}).$$

This formulation of each country's problem assumes away one very basic reason for international cooperation: the exchange of information.

ment in Interdependent Economies," *Quarterly Journal of Economics*, vol. 83 (February 1969), pp. 1-24; and Hamada, "Alternative Exchange Rate Systems" and "A Strategic Analysis."

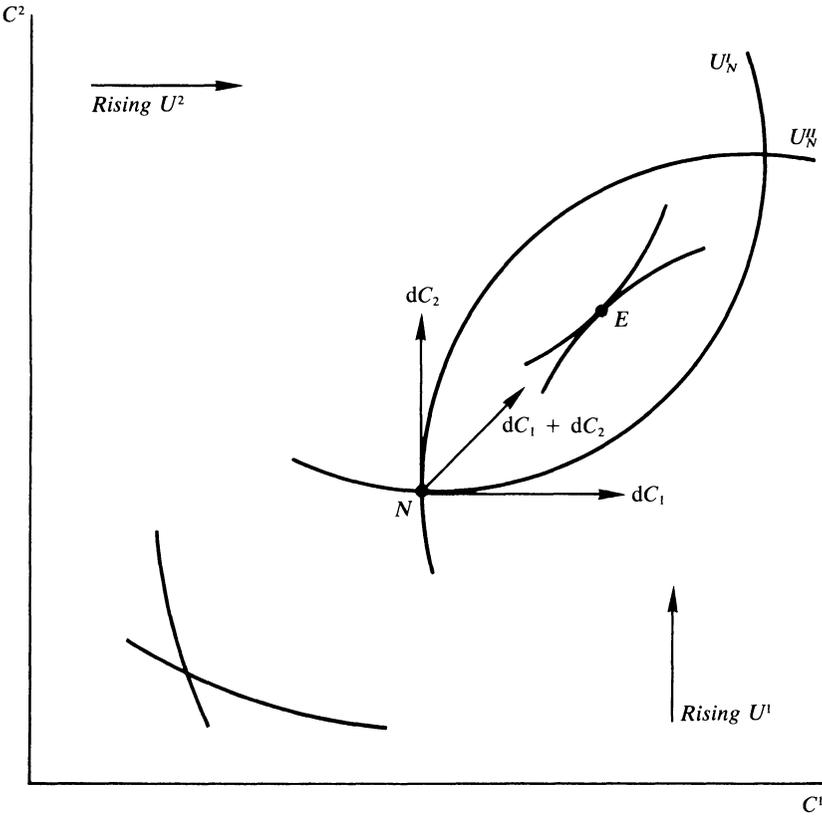
In a Nash equilibrium, every country knows exactly what every other country is doing, and all policymakers agree on the “true” model. Even opponents of active international policy coordination generally recognize the need for the international exchange of information on policy choices.

The important fact about a Nash equilibrium is that it is rarely efficient (or Pareto optimal), in the sense that at least some countries can be made better off without any countries being made worse off by an alternative choice of policy instruments. This fact can be most simply illustrated in the two-economy case where each economy has a single policy instrument. When the foreign country (country 2) chooses its optimal policy C^2 , it sets $\partial U^2/\partial C^2 = 0$. However, for the home country, $\partial U^1/\partial C^2$ will generally not equal zero. Then, a change in C^2 can (to a first-order approximation) leave foreign welfare unchanged while raising utility at home. Consider a change in policy mix $dC^2 = \omega(\partial U^1/\partial C^2)$, where ω is a small positive number. We calculate the resulting changes in U^1 and U^2 , to a first order, as $dU^1 = (\partial U^1/\partial C^2)dC^2$ and $dU^2 = (\partial U^2/\partial C^2)dC^2$. Thus with $dC^2 = \omega(\partial U^1/\partial C^2)$, we see that $dU^1 = \omega(\partial U^1/\partial C^2)^2$ while $dU^2 = 0$ (since $\partial U^2/\partial C^2$ equals 0). Since we can make the same calculation for the home country’s policy, it is easy to see that a change in $dC^1 = \omega(\partial U^2/\partial C^1)$ and $dC^2 = \omega(\partial U^1/\partial C^2)$ will leave both countries better off than in the Nash, noncooperative equilibrium.

It should be noted that when C^2 is perturbed, thereby raising U^1 and leaving U^2 unchanged to a first order, foreign utility U^2 is in fact reduced to a second order. This is because, to a second-order approximation, $dU^2 = (\partial U^2/\partial C^2)dC^2 + \frac{1}{2}[\partial^2(U^2)/(\partial C^2)^2](dC^2)^2$, and at the original Nash equilibrium $[\partial^2(U^2)/(\partial C^2)^2] < 0$. This explains why country 2 cannot simply do country 1 a “favor” by perturbing C^2 . Country 1 gains a lot, but country 2 still does lose a little. Only a joint policy of dC^1 and dC^2 gives both countries a first-order welfare improvement.

A simple diagram can help to clarify the argument for coordination. In figure 1, we draw the indifference curves for countries 1 and 2 in (C^1, C^2) space. The figure is drawn under the assumption that $\partial U^2/\partial C^1$ and $\partial U^1/\partial C^2$ are both positive. At the Nash equilibrium, N , C^1 is chosen to maximize U^1 given C^{2N} , so that the indifference curve for 1 is horizontal at N (that is, $\partial U^1/\partial C^1 = 0$); similarly the indifference curve for 2 is vertical at N . Now, when C^1 is changed in the direction $\omega(\partial U^2/\partial C^1)$, the domestic control is moved by the vector dC^1 . For small changes, $dU^1 \approx$

Figure 1. The Geometry of Policy Coordination



0 and $dU^2 > 0$ (actually, U^1 falls by a second-order term, while U^2 rises by a first-order term). The vertical vector in the figure represents dC^2 . A small rise in C^2 leads to $dU^1 > 0$ and $dU^2 \approx 0$. A cooperative equilibrium would be given by a sum of vectors dC^1 and dC^2 , shown as the upward-sloping vector at point N . It clearly moves into a region of joint welfare improvement. The region between the two indifference curves U_1^N and U_2^N describes the entire set of policy moves that are Pareto improving vis-a-vis N . Note that at point E , the indifference curves of 1 and 2 are tangent. As we shall note momentarily, no movement of C^1 and C^2 from E can be Pareto improving, so E is an efficient policy equilibrium.

Thus, the gains from cooperation are achieved because uncoordinated

policies leave cross-country policy effects like $\partial U^1/\partial C_i^2$ nonzero, while own-country policy effects are set to zero. Let us look at $\partial U^1/\partial C_i^2$ more closely to see the particular circumstances in which $\partial U^1/\partial C_i^2$ might (inadvertently) be equal to zero. In fact $\partial U^1/\partial C_i^2 = (\partial U^1/\partial T^1)(\partial T^1/\partial C_i^2)$. That is, the effect of C_i^2 on U^1 is given by the effects of C_i^2 on the targets in country 1, multiplied by the marginal welfare effects of T^1 on U^1 . There are three major ways in which this total effect may be zero. Most directly, $\partial T^1/\partial C_i^2$ might equal zero because there is no effect of country 2's policies on the foreign target variables. The economies are simply decoupled, at least for that policy instrument.

Second, the effects of C_i^2 on T^1 might be the same as the effects of a linear combination of country 1's own controls on its own targets, so that $\partial T^1/\partial C_i^2 = \sum_{i=1}^l \lambda_i (\partial T^1/\partial C_i^1)$. In this case, country 1 can undo any effects of C_i^2 on its targets. Since in its own optimization program it sets $(\partial U^1/\partial T^1)(\partial T^1/\partial C_i^1) = 0$ for $i = 1, \dots, l$, we see immediately that $(\partial U^1/\partial T^1)(\partial T^1/\partial C_i^2) = \sum_{i=1}^l \lambda_i (\partial U^1/\partial T^1)(\partial T^1/\partial C_i^1) = 0$. This is a crucial point: the inefficiency of uncoordinated policymaking arises not from the mere fact of interdependence, but because one country's policies affect another's targets in a way that is (linearly) distinct from that country's abilities to affect its own targets.

The third, and least interesting way, that $\partial U^1/\partial C_i^2$ may equal zero is that country 1 has, on its own, enough policy instruments to reach all of its targets. Define the "bliss" point for country 1 as the m -tuple $\hat{T}^1 = (\hat{T}_1^1, \hat{T}_2^1, \dots, \hat{T}_m^1)$ such that $U(\hat{T}^1) > U(T^1)$ for all other possible values of the targets. At the bliss point, $\partial U^1/\partial T^1 = 0$ as a property of an optimum. Thus at \hat{T}^1 , $\partial U^1/\partial C_i^2 = (\partial U^1/\partial T^1)(\partial T^1/\partial C_i^2) = 0$. If the home country has reached its bliss point, it does not care about small perturbations in C^2 , since these will have (at most) second-order consequences for national welfare.

Perturbation arguments at the Nash equilibrium establish a direction of movement of the policy variables that leaves both countries better off. Such arguments do not, however, establish the distance that policies should be moved. At what point is a further coordinated movement of policies futile? We define a vector of policies (C^1, C^2) as efficient if there is no Pareto-improving selection of policies, and we define C^E as the set of efficient policy vectors.¹⁴

14. Formally, (C^1, C^2) is efficient if and only if there does not exist a feasible vector (\hat{C}^1, \hat{C}^2) such that $U^1[T(\hat{C}^1, \hat{C}^2)] \geq U^1[T(C^1, C^2)]$ and $U^2[T(\hat{C}^1, \hat{C}^2)] \geq U^2[T(C^1, C^2)]$, with strict inequality in at least one case.

Mathematically, it is easy to characterize efficient policy choices, since every efficient policy vector maximizes the weighted sum of utilities $w^1U^1(T^1) + (1 - w^1)U^2(T^2)$, for some weight $0 \leq w^1 \leq 1$. By maximizing this weighted sum with respect to C^1 and C^2 for all possible weights w^1 and $(1 - w^1)$, we can identify all efficient policy packages. Consider a set of policies that maximizes $w^1U^1 + (1 - w^1)U^2$ for some w^1 . At a maximum, we know that $w^1\partial U^1/\partial C^1 + (1 - w^1)\partial U^2/\partial C^1 = 0$. It is now easy to verify that at such an equilibrium, any policy perturbation that raises U^2 must lower U^1 . That is, all gains from trade have been exploited. For small changes in C^1 we have

$$\begin{aligned} dU^1 &= (\partial U^1/\partial C^1)dC^1 \\ &= -[(1 - w^1)/w^1](\partial U^2/\partial C^1)dC^1 \\ &= -[(1 - w^1)/w^1]dU^2. \end{aligned}$$

Thus, for any change in C^1 , dU^1 and dU^2 necessarily move in opposite directions.

SOME ILLUSTRATIONS OF THE GAINS FROM TRADE

A major task of international economics should be to discover the sources of gains from trade in macroeconomic policies. In the study of real trade theory, for example, economists have long recognized the possibility of mutual advantage in multilateral tariff reductions, but much less thought and energy has so far gone into the question of advantageous coordination in the monetary and fiscal sphere. In the remainder of this section we offer illustrations of those gains. Then we turn to large-scale macroeconomic models to find, via numerical simulation, the empirical importance of some of these channels. It should be noted at the outset that while an analytical characterization of efficient policies C^E is difficult or impossible for a large-scale model, a full numerical treatment is relatively straightforward.

Let us turn first to a case where interdependence exists but where there are no gains to cooperation. Suppose inflation is given by $\pi = \tau Q$ and the GNP gap is a function of domestic monetary (M) and fiscal (G) policies and foreign policies M^* and G^* : $Q = a_1M + a_2G + a_3M^* + a_4G^*$. We know from our theoretical work that a_3 and a_4 may be positive or negative. For our purpose here we assume only that $a_1 + a_3 > 0$ and $a_2 + a_4 > 0$, that is, that direct effects dominate indirect effects if the latter are negative. Comparable equations hold for foreign output

and inflation. Domestic utility is a function of the target vector $T = T(Q, \pi)$, with $U = U(T)$. Clearly, domestic authorities will choose M such that $(\partial U/\partial T)(\partial T/\partial M) = 0$. Here, $\partial T/\partial M = (a_1, a_1\tau)$. A change in M^* will affect utility as $(\partial U/\partial T)(\partial T/\partial M^*)$, but since $\partial T/\partial M^* = (a_3, a_3\tau) = a_3/a_1(\partial T/\partial M)$, we see that $(\partial U/\partial T)(\partial T/\partial M^*) = (a_3/a_1)(\partial U/\partial T)(\partial T/\partial M) = 0$. There will be no scope for cooperation. Even if the home country could choose M^* and G^* it would find it superfluous to do so, since M^* and G^* affect home country targets in exactly the same way as M and G , up to a constant of proportionality.

Suppose now that the country's authorities target the current account balance (or changes in external indebtedness) as well as π and Q . Now, $U = U(Q, \pi, CA)$. With symmetric countries, the current balance will depend only on the differences $M - M^*$ and $G - G^*$, since $CA^* = -CA$. Then, $CA = \beta_1(M - M^*) + \beta_2(G - G^*)$. A fiscal expansion will almost surely worsen the external balance, so that $\beta_2 < 0$. A monetary expansion, we have noted, tends to improve CA via currency depreciation, but also to worsen CA via the direct effect demand expansion. In line with the empirical evidence in tables 5 and 6, we assume $\beta_1 < 0$. Consider the effects of the controls on the country targets:

$$(15) \quad \begin{aligned} Q &= a_1M + a_2G + a_3M^* + a_4G^* \\ \pi &= a_1\tau M + a_2\tau G + a_3\tau M^* + a_4\tau G^* \\ CA &= \beta_1(M - M^*) + \beta_2(G - G^*). \end{aligned}$$

Now, $\partial T/\partial M = (a_1, a_1\tau, \beta_1)$ and $\partial T/\partial M^* = (a_3, a_3\tau, -\beta_1)$. The vectors $\partial T/\partial M$ and $\partial T/\partial M^*$ are no longer linearly dependent, thus $\partial U/\partial M^*$ will be nonzero. To be more precise: $\partial U/\partial M = u_1a_1 + u_2a_1\tau + u_3\beta_1 = 0$, where $u_i = \partial U/\partial T_i$. We assume that $u_1 > 0$ (more output preferred to less), $u_2 < 0$ (less inflation preferred to more), and $u_3 > 0$ (higher trade balance preferred). Now $\partial U/\partial M^* = u_1a_3 + u_2a_3\tau - u_3\beta_1$, which upon substituting $\partial U/\partial M = 0$ yields $\partial U/\partial M^* = -[(a_1 + a_3)/a_1]u_3\beta_1$, which is greater than zero. Thus higher M^* raises home welfare. But since at the initial equilibrium $\partial U^*/\partial M^* = 0$, a slight rise in M^* will raise U without changing (to a first order) U^* . By symmetric reasoning, M can be raised at home without a loss of welfare while providing a (first-order) gain in welfare abroad. A joint expansion of M and M^* will therefore raise both U and U^* , and a similar argument guarantees that a joint fiscal expansion is also welfare improving. In sum, when policymakers prefer a larger trade surplus, and macroeconomic expansion worsens the trade balance,

there will be a tendency toward overcontraction in the world economy. Geometrically, the Nash equilibrium will lie to the lower left of the efficient, symmetric equilibrium, as shown in figure 1.

Now let us refine the model further, to allow for differential exchange rate effects of monetary and fiscal policy. With symmetric economies, the real exchange rate will be given as a function of the difference between M and M^* and the difference between G and G^* :

$$(16) \quad \lambda = \alpha_1(M - M^*) + \alpha_2(G - G^*) \quad \alpha_1 > 0, \alpha_2 \leq 0.$$

Because a monetary expansion depreciates the real exchange rate, α_1 is surely positive. With a high substitutability, σ , of home and foreign assets, α_2 will be negative, while with σ small, α_2 will be positive. The current balance and output are written as before. Finally, inflation is written as a rising function of λ :

$$(17) \quad \pi = \tau Q + \theta \lambda.$$

In choosing domestic monetary policy in the Nash regime, the home authority will set $(\partial U/\partial T)(\partial T/\partial M)$ equal to zero, or $u_1 a_1 + u_2(\tau a_1 + \theta \alpha_1) + u_3 \beta_1 = 0$, with u_i the partial derivatives of $U(Q, \pi, CA)$. At the Nash equilibrium, $(\partial U/\partial T)(\partial T/\partial M^*) = u_1 a_3 + u_2(\tau a_3 - \theta \alpha_1) - u_3 \beta_1$. Using $(\partial U/\partial T)(\partial T/\partial M) = 0$, we have $(\partial U/\partial T)(\partial T/\partial M^*) = -(u_3 \beta_1 + u_2 \theta \alpha_1)[(a_1 + a_3)/a_1]$. Under the assumptions that (1) a higher trade balance is preferred, $u_3 > 0$; (2) a monetary expansion worsens or has little effect on the current account balance, $\beta_1 \leq 0$; and (3) less inflation is preferred, $u_2 < 0$; then $(\partial U/\partial T)(\partial T/\partial M^*)$ is positive. That is, the countries would gain by a joint monetary reflation.

Consider $(\partial U/\partial T)(\partial T/\partial G^*)$. By direct substitution this term equals $u_1 a_4 + u_2(\tau a_4 - \theta \alpha_2) - u_3 \beta_3$. At the Nash equilibrium, $0 = (\partial U/\partial T)(\partial T/\partial G) = u_1 a_2 + u_2(\tau a_2 + \theta \alpha_2) + u_3 \beta_2$, so that

$$(\partial U/\partial T)(\partial T/\partial G^*) = -(u_3 \beta_2 + u_2 \theta \alpha_2)[(a_2 + a_4)/a_2].$$

Since $a_2 \geq 0$, it appears that $(\partial U/\partial T)(\partial T/\partial G^*)$ is of ambiguous sign. However, as a property of the Nash equilibrium, we can show that $u_3 \beta_2 + u_2 \theta \alpha_2 < 0$, so that the sign is positive (assuming, as before, that $u_1 > 0$, $u_2 < 0$, and $u_3 < 0$). Since $(\partial U/\partial T)(\partial T/\partial G^*)$ is positive, we again find a tendency toward overcontraction, this time in fiscal policy. A joint fiscal reflation at the Nash equilibrium raises welfare in both countries.

To show that $u_3\beta_2 + u_2\theta\alpha_2 < 0$, start with $0 = (\partial U/\partial T)(\partial T/\partial M) = u_1a_1 + u_2(\tau a_1 + \theta\alpha_1) + u_3\beta_1$. By rearrangement, $u_1 + \tau u_2 = -(1/a_1)(u_3\beta_1 + u_2\theta\alpha_1)$. Assuming $\beta_1 < 0$, $\alpha_1 > 0$, $u_3 > 0$, and $u_2 < 0$, we see that $u_1 + \tau u_2 > 0$. Now consider $0 = (\partial U/\partial T)(\partial T/\partial G) = u_1a_1 + u_2(\tau a_2 + \theta\alpha_2) + u_3\beta_2$. We see that $u_1 + \tau u_2 = -(1/a_2)(u_3\beta_2 + u_2\theta\alpha_2)$. Since $a_2 > 0$ and $u_1 + \tau u_2 > 0$, we find immediately that $u_3\beta_2 + u_2\theta\alpha_2$ must be negative, as we wanted to show.

Under our specific assumptions, both M and G will tend to be too contractionary at the Nash equilibrium, so that utility will rise when both $dG = dG^* > 0$ and $dM = dM^* > 0$. Under alternative assumptions on the signs of u_1 , u_2 , u_3 ; on the policy multipliers; or on the targets in the objective function, the bias towards overcontraction can be reversed. Indeed, in cases where fiscal expansion causes a currency appreciation, and thus allows an economy to export its inflation abroad, it is not difficult to construct examples where monetary policy is overcontractionary while fiscal policy is overexpansionary, with the overall mix being overcontractionary. To summarize, an uncoordinated selection of macroeconomic strategies is likely to lead to an inefficient mix of monetary and fiscal policies and to an inefficient overall stance on the level of output selected.

In the empirical work that follows, we will use a quadratic utility function, since it results in linear policy rules. For example, we will specify U as $-\frac{1}{2}[\mu(Q - \hat{Q})^2 + \phi(\pi - \hat{\pi})^2 + \psi(CA - \hat{CA})^2]$, where \hat{Q} , $\hat{\pi}$, and \hat{CA} are the targets (or bliss points) for Q , π , and CA . In this case, the marginal utility of Q , π , and CA depend on their respective distances from \hat{Q} , $\hat{\pi}$, \hat{CA} , with $u_1 = -\mu(Q - \hat{Q})$, $u_2 = -\phi(\pi - \hat{\pi})$, $u_3 = -\psi(CA - \hat{CA})$. Thus, inflation will be important on the margin when inflation is very high; the current account deficit is important on the margin when CA is very low relative to \hat{CA} ; and so on.

It is not hard to generalize our results to cases of asymmetric economies. If fiscal expansion in the United States tends to appreciate the dollar while a foreign fiscal expansion depreciates the foreign currency, then it is possible that a U.S. fiscal contraction will lower foreign utility while a foreign fiscal expansion will raise U.S. utility. Thus a move from the Nash equilibrium to the cooperative equilibrium may involve a move of G and G^* in opposite directions. We will return to the U.S. policy mix shortly.

SOME DYNAMIC CONSIDERATIONS IN POLICY COORDINATION

So far, we have analyzed the possibility of welfare-improving swaps of macroeconomic policy in a static planning environment. Now we consider some of the implications of moving to a more appropriate, multiperiod setting. At one level little is changed; it is still easy to demonstrate conditions under which policy actions in the two countries are Pareto improving. But at another level, much is changed. To the extent that the private sector acts in anticipation of government policies, the nature of government policy optimization may be radically altered.

The formal apparatus for the intertemporal optimization problem is fairly intricate, so only the general approach is sketched here.¹⁵ We consider that each economy has an intertemporal objective function of the form $V_0 = \sum_{t=0}^{\infty} \delta^t U(Q_t, \pi_t, CA_t)$. In the dynamic setting, with forward-looking agents, it is typical that in reduced form Q , π , and CA are functions of current and future values of M , M^* , G , and G^* . For the moment let us avoid that complexity and write in the usual way that $Q_0 = a_1 M_0 + a_2 G_0 + a_3 M_0^* + a_4 G_0^*$ and $CA_0 = \beta_1(M_0 - M_0^*) + \beta_2(G_0 - G_0^*)$. Also, write π_t in the simple form $\pi_t = \pi_{t-1} + \tau Q_t$.

In this case, π is a state variable of the system, and with π there is a co-state variable $\chi < 0$ that measures $\partial V_t / \partial \pi_t$; that is, χ is the marginal loss in intertemporal utility caused by inheriting a higher rate of inflation. It is well known that the dynamic optimization problem may be rewritten as a static optimization problem by using the co-state variable:

$$(18) \quad \max H = u(Q_0, \pi_0, CA_0) + \chi_1 \pi_1$$

such that

$$\pi_0 = \pi_{-1} + \tau Q_0; \quad Q_0 = a_1 M_0 + a_2 M_0^* + a_3 G_0 + a_4 G_0^*$$

$$\pi_1 = \pi_0 + \tau Q_1; \quad CA_0 = \beta_1(M_0 - M_0^*) + \beta_2(G_0 - G_0^*).$$

Now the argument proceeds as before.

15. See Miller and Salmon, "Dynamic Games," and Sachs, "International Policy Coordination," for some details.

At the noncooperative equilibrium, it must be that $\partial H/\partial M_0 = 0 = u_1 a_1 + u_2 a_1 \tau + u_3 \beta_1 + \chi_1 \tau a_1$. Also, $\partial H/\partial M^* = u_1 a_1 + u_2 a_3 \tau - u_3 \beta_1 + \chi_1 \tau a_3$. By combining these two expressions we find $\partial H/\partial M^* = -u_3 \beta_1 [(a_1 + a_3)/a_1]$. Once again, assuming that a monetary expansion worsens the trade balance ($\beta_1 < 0$) and that a larger trade balance surplus is preferred to a smaller trade balance surplus ($u_3 > 0$), then $\partial H/\partial M_0^* > 0$, and a foreign monetary expansion would tend to raise home welfare. With symmetric countries, a common rise in M_0 and M_0^* would raise both V and V^* . In summary, the fact that the optimization problem is now dynamic does little, in this case, to change the method of analysis or the specific conclusions regarding monetary policy.

The problem becomes considerably more complicated when current target variables are functions, via rational expectations, of future policy variables. Not only is the computational complexity increased, but the logic of optimizing $V_0 = \sum_{t=0}^{\infty} \delta^t U(Q_t, \pi_t, CA_t)$ is called into question, as Kydland and Prescott first explained.¹⁶ In maximizing V_0 , the policymaker must choose at $t = 0$ an entire path of M and G , that is, $M_0, M_1, \dots, G_0, G_1, \dots$. The problem arises that at $t = 1$, when the policy authority reconsiders the problem of maximizing V_1 , it will typically be optimal to choose a new path $\tilde{M}_1, \tilde{M}_2, \tilde{M}_3, \dots, \tilde{G}_1, \tilde{G}_2, \dots$, where $M_t \neq \tilde{M}_t$ and $G_t \neq \tilde{G}_t$. Policymakers will always want to deviate from their initial "optimal" plans. They will announce one thing and then have an incentive to do another after one planning period. Time inconsistency arises whenever the private sector takes action dependent on anticipations of future policies (for example, in formulating asset demands). Time inconsistency is "solved" in one of two ways. The policymaker may value his reputation for consistency so much that he decides to stick with the original plan, even though it is suboptimal from the current vantage point; or the policymaker may announce a suboptimal but time-consistent set of policies, in which there is no incentive to alter the original plans over time. We pursue this issue in Oudiz and Sachs but not further here.¹⁷

16. See Finn E. Kydland and Edward C. Prescott, "Rules Rather than Discretion: The Inconsistency of Optimal Plans," *Journal of Political Economy*, vol. 85 (June 1977), pp. 473-91.

17. See Gilles Oudiz and Jeffrey Sachs, "Dynamic Games of Macroeconomic Policy in a Multicountry Model," to be presented at the Centre for Economic Policy Research Conference on Policy Coordination, June 1984.

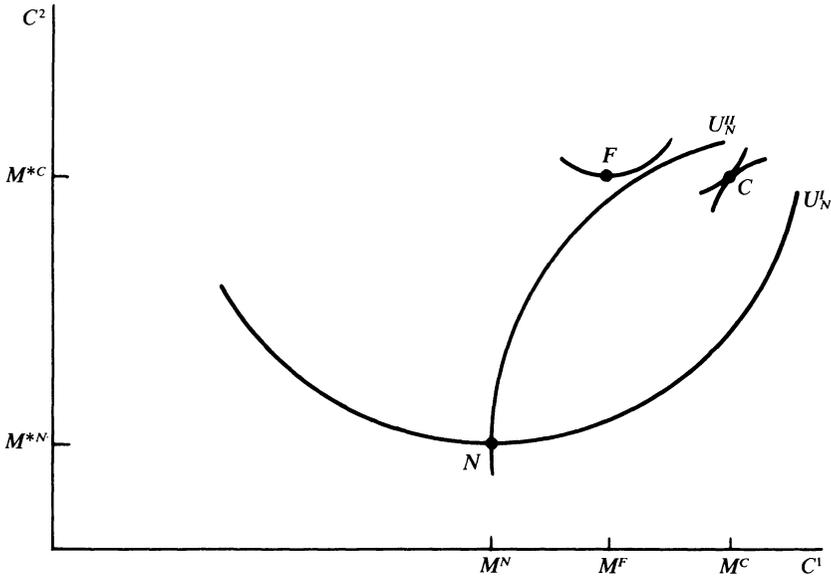
ACHIEVING A COOPERATIVE EQUILIBRIUM

We have shown so far that there generally exist policy options at a noncooperative (N) equilibrium in which all countries can be made better off. Getting from N to a Pareto-improving point is not, however, as simple as it might appear. Precisely because the Pareto-improving points are not Nash equilibriums, it means that at least one country will have an incentive to deviate from such a point if it assumes that the other country's policy is fixed. Figure 2 is instructive. The Nash equilibrium is N , Pareto dominated in welfare terms by C . However, if the foreign country expands its money supply from M^{*N} to M^{*C} , the best response for the home country is M^F , given by the tangency of the home country's indifference curve with the horizontal line M^{*C} ; yet, if the foreign country chooses M^{*C} while the home country "responds" with M^F , the foreign country is actually worse off than at N .¹⁸ Assuming a unique Nash equilibrium, N is the only point at which both countries are content to stay put, taking as given what the other country is doing.

There are two related issues in the move from N to a point like C . First, which point C should be (or will be) chosen among all of the Pareto-improving points? Second, how can the equilibrium C be enforced given the incentives of each country to move unilaterally from C ? We have little to add to various well-known comments on these questions. On the set of desirable points, most models of bargaining restrict the outcome to lie in the efficient set, from which further improvements in one country's welfare are possible only at the expense of losses elsewhere. To enforce such an equilibrium, there might be (1) a policing authority that imposes sanctions on violators, (2) a set of rules (such as a fixed exchange rate linking M and M^*) that are enforced but within which the various countries are free to act without external sanction, or (3) an equilibrium upheld by reputation, in which the failure to stick by one's word reduces the scope for making agreements with other countries in the future. We will return to questions of institutional arrangements for cooperation in the concluding section.

18. Actually, F could have been to the right of the foreign indifference curve through N , in which case both countries would be better off than at N . However, even in this case, the foreign country would have an incentive to move away from M^{*C} , assuming that the home country stays at M^F .

Figure 2. Enforcement Problems with the Cooperative Equilibrium



In our numerical illustrations, we choose the cooperative point to be the “Nash bargaining solution” to the policy game played by the macroeconomic authorities in the various countries. (Note well that the Nash bargaining solution is not the same as the Nash equilibrium, which is the point N in figure 1.) In a series of influential articles, Nash described procedures for picking a point C in a bargaining environment, assuming that the outcome at C is fully enforceable. In a first approach he described a series of axioms to guide the choice. In later studies, Nash and others proposed various noncooperative games whose rules lead to precisely the same point as determined by the axioms.¹⁹

In the Nash bargaining solution there is a “threat point” that is assumed to occur if cooperation breaks down. It is natural to take this point to be the noncooperative equilibrium point N in figures 1 and 2. At N , each country i has utility U^{iN} . The point C is then determined as the feasible point that maximizes the gain in utility over the threat point N , where the gain is measured by the following product:

19. For a detailed discussion of the Nash bargaining solution and related concepts, see Alvin E. Roth, *Axiomatic Model of Bargaining*, Lecture Notes in Economics and Mathematical Systems, no. 170 (Springer-Verlag, 1979).

$$\text{Gain} = (U^{1C} - U^{1N})(U^{2C} - U^{2N})(U^{3C} - U^{3N}) \dots (U^{nC} - U^{nN}).$$

The point C will have to be efficient (otherwise it is obvious that the gain could be raised by moving to a Pareto-superior point). We will solve for C numerically in the examples that follow.

Simulating Coordination of Economic Policies with a Large-Scale Econometric Model

The gains from cooperation seem obvious when one refers to a simple two-country symmetric model. It is, however, much more difficult to assess these gains empirically. Real-world policymaking involves neither symmetric countries nor only two countries. On the contrary it is the diversity of the countries involved and the wide range of their objectives that make cooperation a delicate issue and cooperation so hard to achieve.

In this section we shall try to give an empirical evaluation of the outcomes of cooperative or noncooperative policymaking among the United States, West Germany, and Japan. To simplify the problem and make it tractable we will retreat from a full dynamic framework and consider instead the static model in which the economies are represented by a set of multipliers that link the various “targets” of each country to the policy instruments of all of the countries. These multipliers are taken first from the MCM and then from the EPA model.

Our strategy is as follows. Let T be the vector of targets, $T = (T^1, T^2, \dots, T^n)$, with $T^i = (T^i_1, T^i_2, \dots, T^i_m)$. We start with a baseline or “central variant” projection of T , denoted T^B ; in fact T^B will be taken essentially from a simulation of the MCM for the period 1984–86. Let C be the vector of policy controls, $C = (C^1, C^2, \dots, C^n)$. The matrix Γ contains the policy multipliers linking C to T , so that $T = \Gamma C + T^B$ if we make the important assumption of linearity. Thus when $C = 0$, then $T = T^B$ according to this normalization.

Next we assume that the baseline is a Nash equilibrium for the n countries. That is, we assume that if $C^1, C^2, \dots, C^{i-1}, C^{i+1}, \dots, C^n$ are all zero at T^B , the optimal policy for the i th country is also $C^i = 0$. This assumption allows us to identify key parameters of each country’s utility function in the case of three targets per country and two instruments. To be specific we assume that $U^i = U^i(Q^i, \pi^i, CA^i)$ and that the controls

are M^i and G^i . At a Nash equilibrium, $\partial U^i/\partial M^i = 0$, so that $0 = u_1(\partial Q^i/\partial M^i) + u_2(\partial \pi^i/\partial M^i) + u_3(\partial CA^i/\partial M^i)$. Similarly, $0 = u_1(\partial Q^i/\partial G^i) + u_2(\partial \pi^i/\partial G^i) + u_3(\partial CA^i/\partial G^i)$. The policy multipliers (such as $\partial Q^i/\partial M^i$) are taken from the econometric models and are therefore "known." The utility function can be normalized by setting $u_1 = 1$ so that we are left with two equations to find two unknowns, u_2 and u_3 . Assuming that the baseline projection is a Nash equilibrium, we solve the equations to get estimates of the marginal utilities of inflation (u_2) and the trade balance (u_3). Once these marginal utilities are known we can calculate directly the marginal returns to policy coordination.

The baseline estimates come from a simulation of the MCM made in late 1983 on the assumption of no dramatic change in policy instruments in the 1984–86 period. The baseline yields a fairly flat path for output inflation and the current account. We converted the MCM trajectory of real GNP into a 1984–86 trajectory of GNP gaps based on our own estimates of Okun's law. Table 8 shows the results of these calculations. We estimate the annual long-run trend growth to be 3.2 percent in the United States, 4.4 percent in Japan, and 3.2 percent in West Germany. According to the MCM baseline, the U.S. GNP continues to grow more rapidly than trend from 1984 to 1986, with the GNP gap averaging 5.5 percent over the period. Japanese growth is projected to be slightly below 4.4 percent, with the GNP gap averaging 6.0 percent over the three-year horizon. German growth is almost exactly 3.2 percent. As shown in the table, U.S. inflation averages 4.4 percent along the baseline; Japanese inflation, 2.6 percent; and German inflation, 3.0 percent. The external balance as a percent of GNP is a deficit of 2.2 percent for the United States and a surplus of 1.5 percent for Japan and 1.1 percent for West Germany. Overall, this baseline accords rather closely with other forecasts that assume unchanging policies in the major countries.²⁰

Next, we turn to the marginal utilities of output, inflation, and the current account ratio (current-account/GNP). The marginal utility of a GNP increase (relative to baseline), sustained for three years, is nor-

20. For example, we may compare the baseline with OECD forecasts in *OECD Economic Outlook* (Paris: OECD, December 1983), p. 14. The OECD projects annual U.S. GNP growth to be 5 percent for 1984, with growth back to trend at 3 percent in the first half of 1985. Japanese growth is forecast to be 4 percent for 1984 and 3 percent in the first half of 1985 (and thus below long-run trend, as in our baseline). German growth is projected at 2.0 percent for 1984, rising to 2.25 percent in the first half of 1985. The price and current account forecasts are also very close.

Table 8. Characteristics of the Multicountry Model Baseline, 1984–86 Averages^a
Percent

Country	Output			Inflation	Current account ratio
	GNP gap, 1983 ^b	Growth of potential GNP	GNP gap, 1984–86 ^c		
United States	-7.3	3.2	-5.5	4.4	-2.2
Japan	-4.4	4.4	-6.0	2.6	1.5
West Germany	-10.4	3.2	-10.7	3.0	1.1

a. Baseline is assumed to be a Nash equilibrium.

b. Derived from Okun's law estimates.

c. Using Multicountry model baseline assumptions.

malized to equal 1.0. The other marginal weights are calculated using the two equations $\partial U/\partial M = 0$ and $\partial U/\partial G = 0$ at the baseline, according to the procedure described in the appendix. The welfare costs, in GNP equivalents, of a 1 percentage point increase in inflation held for three years is measured by u_2 . A value of $u_2 = -2.0$, for example, means that on the margin, policymakers are indifferent between a sustained 1 percentage point rise in inflation and a sustained GNP loss of 2 percent relative to baseline. Similarly, u_3 measures the marginal utility of an increase in the current account ratio of 1 percentage point, sustained over three years. A value of $u_3 = 2$ equates a 1 percentage point increase in the current account ratio with a 2 percent rise in GNP for three years.

Since the EPA policy multipliers differ from those of the MCM, they suggest different values of u_2 and u_3 along the baseline path. The calculated values of u_2 and u_3 for the two models are shown in table 9. In general, we find very high marginal weights for inflation and the current account balance (relative to $u_1 = 1$ for GNP). It is not hard to understand this finding. In both the MCM and the EPA model it is possible to use a combination of M (monetary policy) and G (fiscal policy) to arrive at a GNP expansion with only a slight loss in inflation (π) and the current account. However, if we accept the baseline as a Nash equilibrium, countries are refusing to take this option even though the trade-offs are so favorable. Implicitly this suggests a very high weight on π and CA (the current account ratio) in the objective function. Another interpretation is that the policymakers in the various countries perceive the trade-offs of Q (output) with π and CA to be much less favorable than is suggested by the models. Then, even if they care little about inflation,

Table 9. Partial Derivatives of National Utility Functions at Nash Equilibrium^a
Percent per year

Country	Economic Planning Agency model			Multicountry model		
	Output, u_1	Inflation, u_2	Current account ratio, u_3	Output, u_1	Inflation, u_2	Current account ratio, u_3
United States	1	-5.9	2.9	1	-4.5	0.0
Japan	1	-2.9	4.6	1	-3.6	5.9
West Germany	1	-4.9	1.0	1	-3.0	1.9

a. The marginal utility of a GNP increase (relative to baseline) sustained for three years, u_1 , is normalized to equal one; u_2 and u_3 give the inflation and current account deviations that give the same marginal utility. The Nash equilibrium is taken as the baseline in the Multicountry model shown in table 8.

for example, the perceived rise in inflation for a given increase in GNP might be so high as to rule out an expansionary policy.

Once we have these marginal weights, we can examine the scope for policy coordination. Consider, for example, the effect on utility of country i of a rise in M in country j , $\partial U^i / \partial M^j$. We know that this expression equals $(\partial Q^i / \partial M^j) + u_2(\partial \pi^i / \partial M^j) + u_3(\partial CA^i / \partial M^j)$, which can now be calculated directly. Table 10 reports the values of $\partial U^i / \partial M^j$ and $\partial U^i / \partial G^j$ for all countries i, j . By construction, the own-effects are zero at the Nash equilibrium; all other effects are positive, except for the effect of a Japanese monetary expansion on Germany in the EPA model. Consider, for example, the effect of a U.S. fiscal expansion (1 percent of GNP) on Japan. In the EPA model, $\partial U^j / \partial G^{US} = 0.78$. In other words, a U.S. fiscal expansion is equivalent for Japanese utility to a sustained increase of Japanese GNP of 0.78 percent for three years. According to the MCM the gain is 0.43. Other cross-country effects are considerably smaller. And notably, neither Japanese nor German policies have a significant effect on U.S. utility.

We have established the marginal welfare effects on each country of policy changes in another. But this incremental analysis does not tell us how far the countries should move in the Pareto-improving direction in order to reach an efficient worldwide policy mix. To find the necessary overall movement, we must define global rather than local properties of the utility function. We choose to do this in a simple but admittedly restrictive way by assuming that $U^i(Q^i, \pi^i, CA^i)$ is quadratic in Q^i, π^i ,

Table 10. Cross-Country Gains from Fiscal and Monetary Expansion at Nash Equilibrium^a

Percent per year

Country acting, and policy	Economic Planning Agency model			Multicountry model		
	United States	Japan	West Germany	United States	Japan	West Germany
<i>United States</i>						
Fiscal	0.00	0.78	0.18	0.00	0.43	0.35
Monetary	0.00	0.13	0.03	0.00	0.15	0.05
<i>Japan</i>						
Fiscal	0.02	0.00	0.01	0.07	0.00	0.00
Monetary	0.05	0.00	-0.03	0.02	0.00	0.02
<i>West Germany</i>						
Fiscal	0.01	0.53	0.00	0.07	0.17	0.00
Monetary	0.00	0.10	0.00	0.05	0.12	0.00

a. Nash equilibrium is taken as the baseline shown in table 8. The welfare gains are expressed in output-equivalents, that is, one unit of gain is equivalent to a sustained 1 percent increase in affected country's GNP for three years. The unit of fiscal policy is a sustained increase of government spending equal to 1 percent of GNP. The unit of monetary policy is a sustained decrease of the discount rate by 100 basis points.

CA^i , with a bliss point at a zero GNP gap, zero inflation, and a CA target of \hat{CA}^i . (For the United States, the external balance goal is taken to be zero; for Germany and Japan, the goal is taken to be 2 percent of GNP.) Let $(Q^i)^B$, $(\pi^i)^B$, and $(CA^i)^B$ be the values of Q^i , π^i , and CA^i along the baseline. The following utility function satisfies the bliss point and has the marginal utilities $(1, u_2^i, u_3^i)$ that we calculated earlier:

$$(19) \quad U^i = -1/2 [(1/Q^{iB})(Q^i)^2 + (u_2^i/\pi^{iB})(\pi^i)^2 + (u_3^i/\tilde{CA}^{iB})(\tilde{CA}^i)^2],$$

where $\tilde{CA}^{iB} = CA^{iB} - \hat{CA}^i$, and $\tilde{CA}^i = CA^i - \hat{CA}^i$. It is easy to verify that $U^i(0, 0, \hat{CA}^i) = 0$ and that $\partial U^i/\partial Q^i = 1$, $\partial U^i/\partial \pi^i = u_2^i$, and $\partial U^i/\partial CA^i = u_3^i$ when the derivatives are calculated at the baseline. We rewrite this function as:

$$(20) \quad U^i = -1/2 [\mu_i(Q^i)^2 + \phi_i(\pi^i)^2 + \psi_i(\tilde{CA}^i)^2],$$

where μ_i , ϕ_i , and ψ_i are as shown in equation 19. The numerical values of μ_i , ϕ_i , and ψ_i are shown in table 11.

By construction, the baseline path is the noncooperative (N) equilib-

Table 11. Utility Function Parameters^a

Country	Economic Planning Agency model			Multicountry model		
	Output, μ_i	Inflation, ϕ_i	Current account ratio, ψ_i	Output, μ_i	Inflation, ϕ_i	Current account ratio, ψ_i
United States	0.07	0.49	0.47	0.07	0.37	0.00
Japan	0.06	0.40	3.38	0.06	0.52	4.35
West Germany	0.03	0.60	0.40	0.03	0.37	0.68

a. The parameters are normalized so that the marginal utility, at the baseline, of an increase in GNP maintained for three years is equal to one. See equations 19 and 20 for definitions of parameters.

rium. We find the cooperative equilibrium (C) as the solution to the Nash bargaining problem:

$$\max_{\substack{M^1, M^2, \dots, M^n \\ G^1, G^2, \dots, G^n}} (U^{1C} - U^{1N})(U^{2C} - U^{2N}) \dots (U^{nC} - U^{nN}).$$

This maximization is restricted to the set of feasible policies for M and G . We impose no restrictions on G but for M we require that discount rates remain positive. In practice we allow a maximum cut of 5.8 percentage points in the German discount rate and 5.5 percentage points in the Japanese rate (the U.S. constraint did not prove to be binding in any of the simulations). The solution is calculated numerically by an optimal gradient search routine.

At this point it should be noted that the parameters of the utility functions are dependent both on the baseline and on the policy trade-offs the countries face. Let us make this point clear by using a simple example. Consider a single country with two objectives: the output gap, Q , and inflation, π ; and one instrument: fiscal policy, G . The policy multipliers are 1 for the output and τ for inflation. Thus we have the following equations:

$$Q = G + Q^B$$

$$\pi = \tau G + \pi^B,$$

with the same notation as above. For the baseline to be a Nash equilibrium, the marginal welfare gain for a change in fiscal policy must be zero:

$$\frac{\partial U}{\partial G} = \frac{\partial U}{\partial Q} \frac{\partial Q}{\partial G} + \frac{\partial U}{\partial \pi} \frac{\partial \pi}{\partial G} = u_1 + \tau u_2 = 0.$$

(Note that all of the partial derivatives are evaluated at the baseline.) The partial derivatives are normalized by assuming that

$$\frac{\partial U}{\partial Q} = u_1 = 1.$$

Thus

$$u_2 = -1/\tau.$$

Given the assumptions, u_2 is nothing other than a measure of the output-inflation trade-off. In other words, the partial derivatives of the utility function at the Nash equilibrium are dependent only on the model multipliers.²¹

We now assume that U is quadratic and compute the parameters μ and ϕ :

$$U = -(\mu Q^2 + \phi \pi^2).$$

Since $u_1 = 1$ and $u_2 = -1/\tau$, we have the following equations:

$$u_1 = -\mu Q^B = 1$$

$$u_2 = -\phi \pi^B = -1/\tau,$$

so that

$$\mu = -u_1/Q^B = -1/Q^B$$

$$\phi = -u_2/\pi^B = 1/\tau \pi^B.$$

Note that when π^B is positive, Q^B must be negative; otherwise the baseline cannot be a Nash equilibrium. For example, with $\pi > 0$ and $Q^B > 0$, it is always possible to gain on both targets by a fiscal contraction.

Since the revealed preferences of governments, as measured by μ_i , ϕ_i , and ψ_i , are reflected in the paths of output, inflation, and the current account, we can examine the implicit changes in μ_i , ϕ_i , and ψ_i over time. For example, let us assume that for the 1976–78 period the output gap, inflation, and current account reflect a Nash equilibrium.

Recomputing the parameters of the U.S. government implicit utility function using the multipliers of the MCM for 1976–78, we find quite

21. When three periods instead of one are considered, this is no longer exactly true. The partial derivatives will be affected by a change in the baseline, as is clear from the formulas given in the appendix for u'_1 , u'_2 , u'_3 .

different parameter values from those in table 11. The values of μ_1 , ϕ_1 , and ψ_1 are now 0.10, 0.14, and 2.68, respectively. These new values show a much smaller emphasis on inflation relative to the output gap as measured by the ratio μ_1/ϕ_1 , which increases from 0.2 to 0.7. Similarly, the implied importance of the current account, as measured by ψ_1/μ_1 , was also very much higher in the earlier period.

Each utility function will of course lead to different conclusions concerning the desirability of policy coordination for the United States. In this sense, the advent of the Reagan administration and the much smaller weight it placed on the current account deficit probably reduced the attractiveness of policy coordination for the United States.

COOPERATION IN THE CURRENT MACROECONOMIC ENVIRONMENT

We now proceed to three sets of simulations in order to address the following questions: (1) What improvement of the present situation could be achieved through cooperation among the United States, West Germany, and Japan given unchanged objective functions? (2) What would be the implications for these three economies if the United States unilaterally shifted its policy mix to fiscal contraction and monetary expansion? (3) How beneficial would cooperation be if the three countries had to face a third oil shock about half as large as that of 1979?

Suppose that we regard the baseline trajectory as a Nash equilibrium. Can all countries materially benefit from a coordinated package? Qualitatively, the answer is almost surely yes, and since we have seen that $\partial U^i/\partial G^j > 0$ and $\partial U^i/\partial M^j > 0$ for almost all i, j , the nature of coordination will be a joint reflation. Quantitatively, however, it appears that the gains are slight, at least when policy actions are restricted to the three countries under study. Those who advocate a coordinated expansion as the solution to global unemployment must be presuming (a) a much larger group of countries taking policy actions in response to coordination, (b) a much higher degree of macroeconomic interdependence than appears in the EPA model and the MCM, or (c) objective functions that differ significantly from those of current policymakers. To put the last point another way, it appears to be the anti-inflation bias (or anti-Keynesian views) of policymakers rather than the absence of effective coordination that blocks a general reflation.

Table 12. Policy Optimization in the Multicountry Model, 1984–86

Policy and outcome	United States		West Germany		Japan	
	Baseline (Nash)	Cooperation	Baseline (Nash)	Cooperation	Baseline (Nash)	Cooperation
Welfare gain ^a	...	0.17	...	0.33	...	0.99
Fiscal policy ^b	...	0.52	...	-0.21	...	-1.15
Monetary policy ^c	...	2.14	...	5.80	...	5.50
<i>Deviations from target values^d</i>						
<i>Output</i>						
1984	-5.68	-4.72	-10.50	-9.95	-5.23	-5.41
1985	-4.97	-3.80	-10.70	-9.65	-6.00	-4.45
1986	-5.67	-4.86	-10.91	-9.61	-6.80	-4.42
<i>Inflation</i>						
1984	4.24	4.35	3.16	3.33	2.20	2.26
1985	4.81	5.08	2.92	3.41	2.86	2.95
1986	4.10	4.18	2.89	2.94	2.89	2.86
<i>Current account ratio</i>						
1984	-2.25	-2.42	-0.95	-0.90	-0.31	-0.21
1985	-2.20	-2.44	-0.93	-0.81	-0.56	-0.51
1986	-2.25	-2.45	-0.99	-0.80	-0.64	-0.70

a. The unit of welfare gain is equivalent to a percentage change in GNP, averaged over the three years.

b. The unit of fiscal policy is a sustained increase of government spending equal to 1 percent of GNP.

c. The unit of monetary policy is a sustained decrease of the discount rate by 100 basis points.

d. Target values are as follows: output, full employment; inflation, zero; and current account ratio, zero for the United States and 2 percent for West Germany and Japan. Deviations are in percent for output and percentage points for annual inflation rates and the current account ratio.

The gains from coordination are larger in the MCM (table 12) than in the EPA model (table 13). Consider table 12. The first column for each country shows the baseline for output (GNP gap), inflation, and the current account ratio (relative to target) for the years 1984, 1985, and 1986. By construction, the Nash equilibrium is the same as the baseline. The "cooperation" column shows the result of employing the Nash bargaining solution for each of the three countries. In the first row of the table we measure the welfare gain relative to baseline that comes from cooperation. The magnitude 0.17 for the United States signifies, for example, that coordination is worth an equivalent of 0.17 percent higher GNP over the three-year period. The gain of 0.17 reflects a somewhat larger actual gain in GNP (the GNP gap falls by 0.96 in 1984, 1.17 in 1985, and 0.81 in 1986), minus the welfare costs of a small rise in inflation and a slight worsening of the trade deficit. In West Germany, the welfare gain is 0.33 percent of GNP for three years. Japan is the big winner. The

Table 13. Policy Optimization in the Economic Planning Agency Model, 1984-86^a

Policy and outcome	United States		West Germany		Japan	
	Baseline (Nash)	Cooperation	Baseline (Nash)	Cooperation	Baseline (Nash)	Cooperation
Welfare gain	...	0.03	...	0.03	...	0.37
Fiscal policy	...	-0.11	...	-0.16	...	-0.08
Monetary policy	...	4.30	...	0.86	...	1.88
<i>Deviations from target values</i>						
<i>Output</i>						
1984	-5.68	-5.15	-10.50	-10.79	-5.23	-4.97
1985	-4.97	-4.06	-10.70	-10.84	-6.00	-5.07
1986	-5.67	-5.11	-10.91	-10.44	-6.80	-5.11
<i>Inflation</i>						
1984	4.24	4.32	3.16	3.10	2.20	2.30
1985	4.81	4.83	2.92	2.80	2.86	3.15
1986	4.10	4.19	2.89	2.94	2.89	3.21
<i>Current account ratio</i>						
1984	-2.25	-2.30	-0.95	-0.96	-0.31	-0.25
1985	-2.20	-2.33	-0.93	-1.14	-0.56	-0.51
1986	-2.25	-2.32	-0.99	-1.27	-0.64	-0.69

a. See notes to table 12.

move to a cooperative equilibrium raises Japanese welfare the equivalent of a 0.99 percent rise in GNP over the three-year period.

The cooperative equilibrium is achieved by more expansionary monetary and fiscal policies in the United States, and a mixed policy of fiscal contraction with monetary expansion in West Germany and Japan. It may seem paradoxical that U.S. budget deficits actually increase along the path to cooperation but it must be remembered that the objective function weights were selected so that U.S. policymakers are indifferent, on the margin, between fiscal expansion and fiscal contraction. In any event, the fiscal actions are small relative to the interest rate actions. The biggest gain in coordination comes in making possible a synchronized "worldwide" reduction in central bank discount rates (which fall 2.1 percent in the United States, 5.8 percent in West Germany, and 5.5 percent in Japan).

In table 13, the same exercise is undertaken with the EPA model. The movement from Nash to cooperative equilibrium involves contractionary fiscal policies and expansionary monetary policies in all countries.

Once again, Japan is the big winner (0.37 percent increase in GNP in utility units), while for West Germany and the United States welfare is almost unchanged relative to the Nash equilibrium. In this case, as before, coordination mainly permits a drop in central bank discount rates of almost 1 percentage point in Germany, 2 percentage points in Japan, and 4 percentage points in the United States.

Thus the policy effects of coordination are neither trivial nor huge, while the welfare effects of those policy changes seem rather small outside of Japan. In a sense, as we have noted, much of this could have been gleaned directly from table 6, where we saw that the German and Japanese policy links to the United States are almost nonexistent in the EPA model. We stress one important qualification to this conclusion. The simulations assume that no countries other than the three engaged in the bargaining undertake any policy actions in response to the actions of the United States, Germany, and Japan. However, even if France and the United Kingdom are not direct parties to the bargaining, they may find it desirable to respond with expansionary policies of their own. Unfortunately, we simply did not have available the relevant policy multipliers for the other countries to allow us to incorporate such spillover effects; the MCM, for example, has no French block, so it would be impossible to assess directly the French policy response in that model. (Below, we extend our analysis by assuming that Europe can be modeled as a magnification of West Germany.)

EFFECTS OF A SHIFT IN U.S. POLICY

Our analytical procedure has been to assume that the baseline path represents a Nash equilibrium. For the United States this assumption means that when policymakers balance the pros and cons of fiscal contraction from a macroeconomic point of view, the contractionary effects on output just cancel the gains of lower inflation and a smaller trade deficit. Of course, there are several other interpretations of the present policy stance, the main alternative holding that the costs of today's U.S. fiscal policy are well recognized, and are deemed too high, but a deadlock over how to close the deficit has prevented a change in policy. Would a change in U.S. policy that aimed at reducing the trade deficit dramatically affect the welfare of Germany and Japan, and would it modify our previous appraisal of the effects of coordination?

Table 14. Alternate Baseline, Multicountry Model, 1984–86 Averages^a

Country	Policy shifts		Characteristics of baseline		
	Fiscal ^b	Monetary ^c	GNP gap	Inflation	Current account ratio
United States	-2.0	4.6	-5.9	4.2	-1.8
Japan	-0.4	1.8	-6.0	2.6	1.5
West Germany	-0.3	5.4	-10.9	3.0	1.0

a. The utility weight of the current account ratio is raised to 0.24 from the value of zero used in table 11. As a result, U.S. policy is shifted, as shown, in order to produce the new baseline shown. Germany and Japan also reoptimize their policies and performance.

b. The unit of fiscal policy is a sustained increase of government spending equal to 1 percent of GNP.

c. The unit of monetary policy is a sustained decrease of the discount rate by 100 basis points.

Table 14 presents the main features of an alternate baseline using the MCM in which the utility weight on the U.S. current account, ψ_1 , is raised from 0.0 to 0.24. As a result, the United States modifies the macroeconomic policy mix by reducing government spending by 2 percent of GNP and by lowering the discount rate by 460 basis points, and Germany and Japan reoptimize given their previous utility functions (table 15). The new baseline is assumed, as before, to be a Nash equilibrium.²²

The policy shifts for Germany and Japan implied by these assumptions are qualitatively similar to the U.S. policy shift. Both countries, though to a smaller extent, reduce government spending. The change is more noticeable for monetary policy. Japan lowers its discount rate by 180 basis points while the German discount rate is reduced by 540 points, that is, by a larger amount than in the United States.

One important conclusion from this first step is that if the United States were to implement the above policy shift, interest rates would fall markedly without any coordination among the leading economies; the scope for further expansionary monetary policy thus would be greatly reduced. Surprisingly, this new baseline is, on average, very similar to the original one (table 8) for Japan and Germany. The new U.S. policy leads *ex ante* to a decrease of output of more than 1 percent for Germany and of 0.4 percent for Japan. However, both countries react by implementing expansionary monetary policies that prevent an excessive appreciation of their currencies and a fall in output. For the United

22. Thus the new baseline is designed to include the German and Japanese responses to the U.S. change in revealed preference.

Table 15. Utility Function Parameters in Alternate Baseline, Multicountry Model

<i>Country</i>	<i>Parameters^a</i>		
	<i>Output,</i> μ_i	<i>Inflation,</i> ϕ_i	<i>Current account ratio,</i> ψ_i
United States	0.06	0.34	0.24
Japan	0.06	0.52	4.35
West Germany	0.03	0.36	0.67

a. See equations 19 and 20 for definitions of parameters. The parameters for Germany and Japan are slightly different from those in table 11 because the normalizing condition, $\partial U/\partial Q^i = 1$, is imposed on a different baseline.

States the policy shift induces a reduction in GNP, lower inflation, and a reduction of the current account deficit of close to 0.5 percent of GNP.

We now turn to table 16, which compares the Nash and cooperative equilibria. Contrary to the common presumption, the U.S. policy shift leaves West Germany worse off, with a welfare reduction equivalent to 0.4 percentage point of output on the new baseline. Japan, however, benefits from the depreciation of the dollar. In the cooperative equilibrium, output in the three countries rises by an average of more than 1 percent relative to the new baseline, but the welfare gain is markedly smaller than in our first simulation. Moreover, cooperation fails to restore German welfare to its level under the original baseline, before the U.S. policy mix was changed.

As already noted, the scope for cooperation is here greatly reduced by the simple fact that interest rates are now already low at the Nash equilibrium. The change in monetary policies induced by cooperation among the three countries is correspondingly far smaller. Comparing tables 12 and 16 shows that Germany lowers its discount rate by a mere 0.4 percent. More strikingly, Japan increases its interest rate by more than 1 percentage point.

The results of these simulations call into question the conventional wisdom that U.S. policies are precluding a European recovery. That view makes sense if the U.S. fiscal expansion has a contractionary effect on Europe via high interest rates that overwhelm a direct export effect. We showed above that a U.S. fiscal expansion may be negatively transmitted if the expansion causes a dollar appreciation and a large corresponding price rise in Europe via wage indexation. The econometric estimates of the MCM and the EPA model do not suggest that this

Table 16. Policy Optimization in the Multicountry Model, 1984–86: Alternate Baseline^a

Policy and outcome	United States		West Germany		Japan	
	Baseline (Nash)	Cooperation	Baseline (Nash)	Cooperation	Baseline (Nash)	Cooperation
Welfare gains ^{b,c}	...	0.09	-0.43	-0.23	0.31	0.64
Fiscal policy ^c	...	0.57	...	0.28	...	1.40
Monetary policy ^c	...	1.46	...	0.40	...	-1.28
<i>Deviations from target values^c</i>						
<i>Output</i>						
1984	-8.07	-6.82	-10.72	-10.19	-5.75	-4.20
1985	-5.21	-4.02	-11.00	-9.87	-5.81	-4.10
1986	-4.29	-3.72	-10.99	-9.79	-6.34	-4.83
<i>Inflation</i>						
1984	4.47	4.54	3.38	3.42	2.03	2.03
1985	4.44	4.68	2.73	2.92	2.67	2.94
1986	3.69	3.98	2.96	3.07	3.07	3.26
<i>Current account ratio</i>						
1984	-1.70	-1.79	-1.13	-1.18	-0.39	-0.42
1985	-1.71	-1.87	-0.95	-1.01	-0.58	-0.64
1986	-2.15	-2.21	-0.94	-1.04	-0.54	-0.65

a. The alternate baseline is evaluated under the assumption of a more restrictive U.S. fiscal policy and a more expansionary U.S. monetary policy than in the original baseline.

b. The welfare gain is measured from the original baseline except for the United States.

c. See notes to table 12.

negative transmission exists. The U.S. fiscal expansion is measured as raising output and improving the foreign external balance in Germany and Japan, enough to compensate, according to revealed preferences, for any inflation loss from the strong dollar.

COOPERATION FOLLOWING AN OIL PRICE SHOCK

The deep recession of 1980–82 in the OECD economies came in the wake of the second oil price shock. All of the major economies except Japan adopted sharply contractionary monetary policies in an effort to battle the inflationary consequences of the price shock. One argument holds that the resulting global deflation was excessive from each country's point of view because there was no coordinated policy. In that view, each country tightened its monetary policy in order to strengthen its exchange rate and thereby export some of the inflationary shock to other countries. Given the tight policies pursued elsewhere, each country

had an incentive to tighten up even further until, finally, unemployment rates rose so much that inflation fighting on the margin lost its appeal. Since one country's gain in exchange rate is another's loss, it is clear that the attempt of each country to appreciate vis-à-vis the others is globally futile. If this argument were correct, then cooperation would make possible a general decline in interest rates and a smaller loss of output.

To examine this question, we use the MCM to ask how noncooperative and cooperative policies would be altered if West Germany, Japan, and the United States were hit by a 50 percent increase in oil prices over the 1984–86 period. This shock is about one-half the size of the 1979–80 increase. According to the MCM, such a shock has a direct, stagflationary impact; with unchanged policies it causes a decline in output, a rise in inflation, and a worsened external balance. The direct effects of the shock are evident in table 17 by comparing the (before-shock) baseline for each country with the column labeled baseline plus oil shock.

According to the simulation, an oil shock would induce monetary expansion in the United States and Germany, accompanied by a moderate U.S. fiscal expansion. In Japan, monetary policy turns sharply contractionary and fiscal policy is slightly restrictive. The move to coordination involves a sharp interest rate reduction in the three countries. According to the results of table 17, the swing in U.S. policy is from a very limited fall in interest rates of less than 1 percentage point in the noncooperative regime to a fall in rates of almost 2.5 percentage points under cooperation. The German swing is from a fall of 1.5 percentage points to a noticeable fall of 5.8 percentage points. In Japan, a sharp monetary contraction under Nash equilibrium is abandoned and interest rates remain stable. It must be noted that we have added the oil shock to the 1984–86 baseline, so the gains from cooperation involve both the gains in reaction to higher oil prices and the gains that can be achieved from the initial baseline itself. To get some sense of the role of the oil shock alone in inducing gains from cooperation, we can compare the Nash and cooperative equilibria in tables 17 and 12. The oil shock does not appear to induce any special gains from coordination among the United States, Japan, and West Germany. On the contrary the increase in welfare when moving from the Nash to the cooperative equilibrium is smaller in the oil-shock case for the United States and Japan and essentially the same for Germany.

Table 17. Policy Optimization after an Oil Shock: Multicountry Model^a

Policy and outcome	United States			West Germany			Japan					
	Baseline	Cooperation	Nash	Baseline	Cooperation	Nash	Baseline	Cooperation	Nash			
Welfare gains ^{b,c}	...	-3.73	-3.82	-3.74	-3.87	-4.21	-4.31	-3.87	-4.21	-13.28	-12.28	-11.72
Fiscal policy ^c	0.20	0.72	-0.58	-0.70	...	-0.58	-0.70	...	-0.82	-1.77
Monetary policy ^c	0.86	2.48	5.80	1.54	...	5.80	1.54	...	-7.06	0.00
<i>Deviations from target values^e</i>												
<i>Output</i>												
1984	-5.68	-5.93	-5.66	-4.72	-11.22	-12.07	-10.50	-11.22	-12.07	-5.23	-7.23	-9.21
1985	-4.97	-5.22	-5.28	-4.10	-11.61	-12.88	-10.70	-11.61	-12.88	-6.00	-7.50	-9.95
1986	-5.67	-7.42	-7.10	-6.48	-12.14	-13.65	-10.91	-12.14	-13.65	-6.80	-8.30	-10.75
<i>Inflation</i>												
1984	4.24	6.24	6.28	6.37	4.31	4.30	3.16	4.31	4.30	2.20	5.95	5.65
1985	4.81	5.31	5.42	5.65	3.79	3.29	2.92	3.79	3.29	2.86	3.61	3.33
1986	4.11	3.60	3.67	3.78	2.31	2.72	2.89	2.31	2.72	2.89	2.89	2.41
<i>Current account ratio</i>												
1984	-2.25	-2.98	-3.12	-3.26	-1.58	-1.55	-0.95	-1.58	-1.55	-0.31	-1.69	-1.33
1985	-2.21	-2.66	-2.91	-3.08	-1.13	-1.06	-0.93	-1.13	-1.06	-0.56	-1.46	-1.09
1986	-2.25	-2.76	-3.02	-3.14	-1.45	-1.40	-0.99	-1.45	-1.40	-0.64	-2.25	-1.86

a. Fifty percent increase in oil prices.

b. Relative to preshock baseline

c. See table 12, notes a-d.

Extensions and Qualifications

We offer our estimates of the gains from cooperation as illustrative rather than definitive. The issue of policy coordination is too important to depend on a small set of estimates based on particular objective functions and specific macroeconometric models. Unfortunately, there is no way to test our results against the findings of others, since, as far as we know, ours is the first attempt to quantify the gains from cooperation in large-scale macroeconometric models. We therefore think it worthwhile to mention the sensitivity of our analysis to the following features: the group of countries under study; the particular models under study and the use we made of them; the absence of uncertainty in the treatment of cooperation; and the time horizon for policy planning. We conclude with a brief mention of some institutional aspects of policy cooperation.

THE GROUP OF COUNTRIES

Our empirical study focused on a bargaining game among West Germany, Japan, and the United States. This choice was partly tactical and partly strategic. Tactically, the cross-country multipliers are readily available for these, the three largest market economies; exploring cooperation for a wider group of countries would have required that new policy simulations be undertaken with the MCM and the EPA model. (Conceptually, and computationally, there is no difficulty in extending the analysis to a much larger set of countries.) Strategically, our choice of countries is probably realistic. In general, the smaller economies can probably have a free ride on the policy decisions of the three largest economies. It would be difficult to engage in successful negotiation with a much larger group of countries and still more difficult to monitor an agreement; at most, we might imagine the seven summit countries (Canada, France, Italy, Japan, the United Kingdom, the United States, and West Germany) as formal participants in an enlarged negotiating process.

What is unrealistic, however, is our assumption that no other countries change their policies in response to the bargain struck among the big three. We simply lacked the relevant policy multipliers to incorporate many other countries. It is certainly plausible, however, that German

agreement on a policy package with the United States and Japan might bring about de facto agreement with the rest of the EC on the essential elements. The policy constraints of the European Monetary System would likely push other countries in the EC toward matching the German actions. In that case, the United States would have a much weightier bargaining counterpart, and the U.S. gains from policy coordination might be ipso facto substantially enlarged.

To test this view in a simple way, we have magnified the German policy effects on the United States and Japan by 3, and interpreted the German outcome as an "EC" outcome. The factor of proportionality was selected by examining the effects on the United States of an EC fiscal expansion, and a German fiscal expansion, in a 1980 version of the OECD Interlink model.²³ The effects of the EC expansion on output and the current account were approximately 3 times the effects of Germany alone.

The results of this extension using the MCM are shown in table 18. Comparing tables 12 and 18, we see that the U.S. and Japanese gains from policy coordination are increased by a factor of 3 and the "European" gain by a factor of about 1.7. Once again, the gain is brought about chiefly by a worldwide reduction in interest rates with U.S. rates dropping by more than 400 basis points. All countries have much higher output relative to the Nash equilibrium; Japan gains about 1.8 percent in GNP, on average, for the three years, with virtually unchanged inflation and a larger current account surplus.

Another possible group of countries that might be analyzed is the EC itself. The trade and financial links within the EC are much greater, as a proportion of GNP, than the links among the United States, Europe, and Japan. As we saw in table 1, for example, French exports to the United States represented only 0.9 percent of French GNP, while its exports to Germany are 2.4 percent of GNP. Thus, our findings of modest gains from cooperation among the big three should likely be multiplied severalfold with respect to intra-European cooperation. We suspect that the greater scope for coordination among the European economies is the key reason that European institutions for macroeconomic coordination, such as the European Monetary System, have developed over

23. See Adrian Blundell-Wignall, Flemming Larsen, and Franciscus Meyer-zu-Schlochtern, "Fiscal Policy Simulations with the OECD International Linkage Model," in *OECD Economic Outlook: Occasional Studies* (Paris: OECD, July 1980), pp. 3-32.

Table 18. Policy Optimization with a Coordinated Europe: Multicountry Model

<i>Policy and outcome</i>	<i>United States</i>		<i>Europe^a</i>		<i>Japan</i>	
	<i>Baseline (Nash)</i>	<i>Cooperation</i>	<i>Baseline (Nash)</i>	<i>Cooperation</i>	<i>Baseline (Nash)</i>	<i>Cooperation</i>
Welfare gain ^b	...	0.54	...	0.56	...	2.96
Fiscal policy ^b	...	0.87	...	-0.17	...	-1.01
Monetary policy ^b	...	4.06	...	4.60	...	5.50
<i>Deviations from target values^b</i>						
<i>Output</i>						
1984	-5.68	-3.92	-10.50	-9.91	-5.23	-5.17
1985	-4.97	-3.31	-10.70	-9.46	-6.00	-3.61
1986	-5.67	-4.16	-10.91	-9.41	-6.80	-3.58
<i>Inflation</i>						
1984	4.24	4.45	3.16	3.24	2.20	2.17
1985	4.81	5.28	2.92	3.41	2.86	3.02
1986	4.11	3.90	2.89	2.98	2.89	2.83
<i>Current account ratio</i>						
1984	-2.25	-2.56	-0.95	-0.88	-0.31	-0.14
1985	-2.21	-2.69	-0.93	-0.78	-0.56	-0.36
1986	-2.25	-2.71	-0.99	-0.81	-0.64	-0.49

a. Europe's impact on the United States and Japan is assumed to be three times Germany's impact on these countries.

b. See table 12, notes a-d.

time, while coordination among the summit seven remains less institutionalized. In a future paper, we plan to study the effects of European cooperation using the OECD Interlink model.

USE OF THE MCM AND THE EPA MODEL

There exist at least two serious limitations in our treatment of the macroeconomic models and two in the models themselves. Regarding our treatment, we assume that the models are nearly linear when we treat policy outcomes as equaling the product of a fixed multiplier matrix, Γ , and the vector policy settings, C (remember that $T = C\Gamma + T^B$, where T^B is the baseline path for the target variables). In some cases this assumption might not be bad; a fiscal expansion will probably have about twice the output effect if the expansion is doubled. However, certain effects are inherently nonlinear. An exchange rate depreciation, for example, is more likely to improve the current account balance if the economy is starting in surplus rather than deficit. Thus, the sign of $\partial CA/$

∂M may depend on the policy setting of G . Similarly, the question of whether a devaluation is expansionary or contractionary may depend, via a wealth effect, on a country's ex ante net indebtedness in foreign currency to the rest of the world. France has pursued contractionary policies in 1983–84 partly because the appreciation of the U.S. dollar has raised the franc value of French indebtedness to the rest of the world. In a linearized model, however, the sign of $\partial Q/\partial \lambda$ is assumed to be either positive or negative but unchanging as a function of the country's indebtedness.

A second difficulty in our treatment is the implicit assumption that the "true" model of the world is known with certainty and that exogenous shocks are absent during the planning period. It is well known since Brainard's 1967 work that model uncertainty can substantially affect the appropriate choice of policy instruments and in particular cause less policy activism when multipliers are unknown.²⁴ We have not yet investigated the implications of such uncertainty for the logic of policy cooperation, but it is important to do so. We think Feldstein is correct when he says that such uncertainty is a major practical impediment to greater policy coordination.²⁵

Other limitations reside in the models themselves. Many of the crucial channels of interdependence in recent years depend on the effects of policies on less-developed countries (LDCs). Tight U.S. monetary policies, for example, have raised the real indebtedness of many LDCs, and this shift in income distribution has contributed to a dramatic decline in LDC imports from Europe in 1982–84. Given the rudimentary nature of the rest-of-the-world blocks in the EPA model and the MCM, this effect is surely not measured with appropriate magnitude (if at all). It is probably safe to assume that the impact of U.S. monetary policies on other OECD countries is understated in the EPA model and the MCM because of their inability to model the links of the United States to Europe and Japan via the LDCs.

Another difficulty with the models is that expectations are treated in a wholly mechanical way, making policy simulations subject to the Lucas critique. For reasons suggested by Sims and by Sachs's comment on Sims's paper, we regard the seriousness of this problem to be an empirical

24. William C. Brainard, "Uncertainty and the Effectiveness of Policy," *American Economic Review*, vol. 57 (May 1967, *Papers and Proceedings, 1966*), pp. 411–25.

25. See Feldstein, "The World Economy Today."

matter and read the existing evidence as suggesting a very modest importance of the Lucas critique for short-run policy simulations.²⁶

THE TIME HORIZON

Our simulations assume that monetary and fiscal policymakers seek to maximize a utility function with a three-year horizon. A longer horizon would change the optimal macroeconomic policies of each country and would likely change the gains from coordination. We have seen that a fiscal expansion that causes a real appreciation in the short run is likely to cause a depreciation in the long run. Thus, the attractiveness of a tight monetary and loose fiscal policy mix for inflation control is probably diminished when one takes into account the long-term implications of the mix. If the U.S. currency appreciation is buying a larger future depreciation, the ten-year view would likely look less attractive than the three-year view.

What is less clear is how the gains from coordination would change with longer planning horizons among the policy authorities. Qualitatively, the gains from coordination will still be present, as illustrated in an earlier paper.²⁷ The gains, however, may be reduced quantitatively, since the realization that short-run appreciations will be reversed in the long run may lead noncooperative policymakers to choose policies that are more like the cooperative settings.

One frequent argument holds that policymakers discount the future too highly, since their sights are set on the next election. It is interesting to speculate whether increased cooperation would mitigate or exacerbate this bias. Certainly some forms of policy coordination are helpful, as when weak-currency countries peg to strong currencies (or even adopt those currencies) in order to restrain the tendency toward overly expansionary policies that short planning horizons often engender. Rogoff, on the other hand, has developed an ingenious model in which policy coordination worsens the short-horizon bias.²⁸ In his model, wages are set in advance of macroeconomic policies in each period but

26. See Christopher A. Sims, "Policy Analysis with Econometric Models," *BPEA*, 1:1982, pp. 107–52, and the comment that follows.

27. See Sachs, "International Policy Coordination."

28. See Kenneth Rogoff, "Productive and Counterproductive Cooperative Monetary Policies," International Finance Discussion Paper 233 (Board of Governors of the Federal Reserve System, December 1983).

in anticipation of the macro policies that will be set. Once wages are set, governments have an incentive to expand the economy at a modest marginal cost of higher prices. Since wage setters understand this tendency, they are induced to set high nominal wages in anticipation of it, and the economy is beset with an inflationary bias. One constraint on inflation that remains, however, is each country's fear of a unilateral expansion. Rogoff points out that policy coordination can remove this constraint and worsen the inflation bias by convincing each government that the other governments are going to join in its expansion. The result is that all countries intensify their bias toward excess inflation.

THE INSTITUTIONAL CONTEXT OF POLICY COORDINATION

Our analysis concerns the gains from cooperation without regard to the institutional context in which policy cooperation might occur. No doubt the costs of negotiation must be weighed in a full assessment of the potential benefits from coordination. The Nash bargaining solution assumes, for example, that a policing mechanism exists to enforce a bargaining equilibrium. Does such a mechanism exist? Is reputation enough to sustain a bargaining outcome? What role, if any, should international organizations like the IMF, the EC, and the OECD play in fostering and overseeing cooperative arrangements? Are the summits the natural locus for such activity? These issues are a matter of active study among political scientists and economists. Our hope is that our more formal results can provide an input into this area of research.

One line of analysis is particularly important on the institutional front and that is whether cooperative outcomes can be replicated by essentially noncooperative actions under a new set of rules of the game. For example, we have seen that one reason for cooperation is that under flexible exchange rates there is a tendency to choose monetary and fiscal policy with the goal of moving the exchange rate in one's favor. When countries are fighting inflation, each will try to contract the money supply for the disinflationary benefits of a currency appreciation. With symmetric countries, no country achieves an appreciation, but all suffer a real output contraction.

We can think of at least two mechanisms for overcoming this problem. First, in summit style, the countries might agree to avoid a "competitive appreciation," with the heads of state explicitly endorsing such a common policy. Possibly, a joint reduction in interest rates could be

engineered. Alternatively, new rules for target exchange rate zones might be instituted (as in the European Monetary System), within which countries pursue independent policies. A constrained noncooperative equilibrium might then come very close to the optimal cooperative equilibrium. This alternative approach brings economists deeply into the institutional setting of macroeconomic policy, precisely where they should be in studying the possibility of a greater measure of international cooperation.

APPENDIX

Derivations

HERE are the detailed derivations to which the paper refers. The notation is the same. We consider an n -country world. Country i has m policy targets. Its vector of targets is $T^i = (T^i_1, \dots, T^i_m)$. It has l controls, which are the elements of vector $C^i = (C^i_1, \dots, C^i_l)$. The authorities maximize a welfare function $U^i(T^i)$.

The targets are assumed to be linear functions of the controls:

$$T = C\Gamma + T^B,$$

where $T = (T^1, T^2, \dots, T^n)$ is the overall vector of targets, $T^B = (T^{B1}, T^{B2}, \dots, T^{Bn})$ is the value of T at the baseline, $C = (C^1, \dots, C^n)$ is the overall vector of controls, and Γ is the matrix of multipliers.

In our empirical examples the T^i have nine elements: the values of the output gap, inflation, and the current-account/GNP ratio as a deviation from target over the years 1984 to 1986; the C^i have two elements: the measures of fiscal and monetary policies. More precisely:

$$T^i = (Q_{84}^i, Q_{85}^i, Q_{86}^i, \pi_{84}^i, \pi_{85}^i, \pi_{86}^i, \bar{C}A_{84}^i, \bar{C}A_{85}^i, \bar{C}A_{86}^i)$$

$$C^i = (M^i, G^i).$$

Derivation of the Utility Function

In the paper we describe a two-step procedure. First the marginal utilities of the targets are derived and then we assume that the utility

For all countries, δ is assumed to be equal to 0.1. The three parameters μ_i , ϕ_i , and ψ_i are solutions of the following system of three equations.

$$\partial U^i / \partial M^i = 0$$

$$\partial U^i / \partial G^i = 0$$

$$\partial U^i / \partial Q^i = 1,$$

$$\text{where } \partial U^i / \partial Q^i = \sum_{t=1984}^{1986} (\partial U^i / \partial Q_t^i).$$

In table 9 we gave the partial derivatives of the national utility functions at the baseline with respect to a sustained increase over three years of each target. With our specific utility function,

$$\partial U^i / \partial Q^i = u_1^i = - \sum_{t=1984}^{1986} (1 + \delta)^{(1984-t)} \mu_t Q_t^i$$

$$\partial U^i / \partial \pi^i = u_2^i = - \sum_{t=1984}^{1986} (1 + \delta)^{(1984-t)} \phi_t \pi_t^i$$

$$\partial U^i / \partial CA^i = u_3^i = - \sum_{t=1984}^{1986} (1 + \delta)^{(1984-t)} \psi_t \tilde{C}A_t^i.$$

Note that u_1^i is normalized to 1.0 for all i .

The cross-country gains from fiscal and monetary expansion at the baseline presented in table 10 are given by:

$$\partial U^i / \partial C^j = - T^{Bi} R_i \Gamma_{ij}^T.$$

Because the baseline is a Nash equilibrium, by definition $\partial U^i / \partial C^i = 0$.

Derivation of the Nash and Cooperative Equilibriums

The Nash solution corresponds to the case where each country maximizes its welfare, taking as given the other countries' policies. Thus the problem of country i is:

$$\max_C U^i = - \frac{1}{2} T^i R_i T^{iT}$$

$$\text{subject to } T^i = \sum_j C T_{ij} + T^{Bi}$$

$C^i \in \zeta^i$, where ζ^i is the set of feasible policies.

where μ is the parameter of the quadratic utility function corresponding to Q and

$$\begin{aligned}\beta &= 1 + (1+\delta)^{-1} + (1+\delta)^{-2} \\ \alpha &= Q_{1984}^B + (1+\delta)^{-1}Q_{1985}^B + (1+\delta)^{-2}Q_{1986}^B.\end{aligned}$$

More precisely,

$$\Delta = -\frac{\alpha}{\beta} \{1 - \sqrt{[1 + (2\alpha/\beta)(U^C - U^B)]}\}.$$

It should be noted that Δ is approximately equal to $U^C - U^B$ if the change in utility is small.

Comments and Discussion

Olivier J. Blanchard: This is a very stimulating paper. What makes it a particularly nice paper to discuss is that it has an important and controversial punch line: economic cooperation among the United States, West Germany, and Japan will, at best, achieve modest welfare gains. The scope for U.S. welfare gains in particular is very limited. The job of a discussant is therefore obvious. Rather than to nitpick, it is to see whether a strong case can be made for cooperation. To do so, it is convenient to follow the organization of the paper and to ask two sets of questions. The first concerns country interactions. Are all relevant interactions adequately and fully captured? The second concerns objective functions. Could it be that the way the authors specify countries' objective functions biases the case in some way against coordination?

A bare-bones version of the theoretical model of the paper can be written as a system of four equations for each of two countries:

$$\begin{aligned}q &= a(q, r) + nx(q, q^*, \lambda) \\m - p &= f(q, r) \\r - r^* &= g[(b/(b + \lambda b^*))] \\p &= p(\lambda, g)\end{aligned}$$

The notation is as in the paper: a is absorption, nx net exports, b debt, and asterisks denote foreign variables. The model is Mundell-Fleming with two twists. The first is the replacement of the interest-rate parity relation by a portfolio-balance equation. This is motivated by the poor performance of strict parity equations and by strong theoretical support in favor of such a portfolio relation; there is, however, little or no empirical evidence in favor of the portfolio-balance equation. The second is the presence of a price equation allowing for a direct effect of the real

exchange rate on prices. This is important for policy, and ultimately for coordination, because it implies that fiscal and monetary policies, if they have different effects on the exchange rate, will have different impacts on inflation given output. In this way, the policy mix can affect the trade-off between output and inflation.

The model therefore captures all interactions through labor, goods, and assets markets which we know or think should exist. However, it leaves out one type of interaction that is currently important: the direct interaction among policies. If, for example, we were to attribute most of the increase in European real rates of interest to U.S. monetary and fiscal policies, these policies would account for up to one third of the inflation-adjusted average budget deficit in the European Community by raising real interest payments on debt.

Turning to the two empirical models used in the paper, one initially suspects that these models are unlikely to capture all the interactions of the theoretical model. Looking at their structure, however (or more precisely, at the structure of the EPA model, as I have no familiarity with the other), one is surprised by its similarity to that of the theoretical model. It includes, in particular, the two twists mentioned above: price equations with a potential role for the exchange rate and, more surprisingly in view of the weak empirical evidence, portfolio-balance equations.

The empirical models have rich dynamics. These are not, however, rational-expectation dynamics, and hence they exclude some of the most drastic forms of overshooting and may underestimate the size of movements in the exchange rate. This is probably not a major problem. Overshooting, by its nature, is an exchange-rate movement which eventually reverses itself. A model that does not capture it will, for example, underestimate the short-term effect of a monetary contraction on inflation but overestimate its effect in the medium term. If a government is concerned about both the short and medium terms, ignoring overshooting may not be very misleading.

It is therefore reasonable to conclude that, while the multipliers in tables 5 and 6 are imprecise, they are not systematically biased against coordination. I shall not discuss them, except to note for use below that although U.S. fiscal and monetary policies have opposite effects on the exchange rate, they have roughly the same effects on inflation. The United States appears sufficiently closed that the exchange rate has little direct effect on inflation.

Last, I turn to the specification of objective functions. The strategy of Oudiz and Sachs is to assume that countries are doing their uncoordinated best and to use revealed preferences to recover objective functions. This strategy is clearly the right one: if countries are not, in some sense, doing the best they can, how can we talk of coordination? Thus, I agree with the logic of the approach. But I have some problems with its implementation.

Consider first why we usually believe that a strong case can be made for coordination. We think, for example, of a group of countries experiencing a recession, with each country being reluctant to use fiscal expansion for fear of the effects on the current account. Table 5 shows these effects to be quite large. In this case, coordinated fiscal expansion achieves reflation without current account deficits. The return to coordination is large.

Oudiz and Sachs correctly point out that this view of each country as having only one instrument and two targets is too simple. Countries have at least two instruments, fiscal and monetary policies. In the case just mentioned, they can use a mix of tight fiscal and loose monetary policies and alleviate the current account problem. But they also have more than two targets. Oudiz and Sachs assume the existence of only three: output, the current account, and inflation.

This limited list of targets is particularly objectionable. It implicitly assumes that current stances of fiscal and monetary policies are optimal, so that the current U.S. budget deficit is the result of an unconstrained macroeconomic policy decision. I believe it is evident that little sense can be made of the current U.S. policy without introducing at least a “cost” of decreasing the budget deficit. It is not clear what current estimates really mean. Their treatment implies that current U.S. trade deficits reflect, in large part, indifference of the U.S. government to such deficits: the marginal disutility of current levels of the current account deficit is, using MCM estimates in table 9, equal to zero. The authors attempt to deal with this issue when they assign an arbitrarily higher weight to the current account in table 14, but one cannot judge whether this adjustment goes far enough. It is interesting that they still find that the gains from trade are small, and it makes one wonder how much their specification of targets would have to change in order to overturn that conclusion.

A more appealing specification would likely yield a stronger case for cooperation, at least for the United States. In the current setup, the

United States has three targets and two instruments. However, two of the targets are directly linked: we have seen above that U.S. inflation depends mostly on output and very little on the exchange rate. This implies that, to a first approximation, the United States has two independent targets and two instruments. In this case, as noted by Oudiz and Sachs in their theoretical discussion, whatever the United States can achieve, it can achieve on its own and will not benefit from cooperation. Their results might thus be quite different if there were costs to changing fiscal policy or, equivalently, if a new target were introduced. And the case for coordination would probably be somewhat strengthened. However, it remains true that the multipliers are small enough that their qualitative conclusion of only small benefits from coordination for the United States would probably remain.

Stephen N. Marris: This is an important paper. First, in line with other recent work, it reestablishes the analytical case for the international coordination of macroeconomic policies under a system of flexible exchange rates. Second, and this is its most fascinating originality, it not only recognizes that the gains from such cooperation will depend on countries' preference functions, which may well differ, but goes on from there to try bravely to estimate these from observed behavior. This is a significant technical advance, even though a close look suggests that the results so far achieved are of dubious value.

For the first twenty-five years after the war, with an adjustable peg exchange rate system, the case for macropolicy coordination was generally taken for granted. With quasi-fixed rates, the free-rider problem was very evident. Whether insufficient demand or too much inflation was the problem, each country had an interest in seeing that others took the necessary expansionary (or restrictive) actions. Both rules and "reputation" were used to try to overcome this free-rider problem, with considerable success. The Bonn summit was not the first explicit attempt at macropolicy coordination; it was the last.

In the 1970s, policymakers were strongly influenced by a class of models in which freely floating exchange rates automatically yield a world Pareto optimum, so that attempts to "coordinate" would be at best redundant. This paper (a) sets out rather rigorously the theoretical conditions under which, with floating rates, "coordination" would increase world welfare, and (b) shows that the values of the key

parameters in the best existing empirical models are such that “an uncoordinated selection of macroeconomic strategies is likely to lead to an inefficient mix of monetary and fiscal policies, and to an inefficient overall stance on the level of output selected.” Having thus firmly established the case for expecting gains from coordination, the authors may have been a bit disappointed that their attempt at quantification leads them to conclude that the gains from coordination “appear to be modest.” For the reasons given below, however, this is an overly hasty conclusion.

Over the past three years the United States has been following a strongly expansionary fiscal policy, Japan and West Germany have been following equally restrictive fiscal policies, and all three have been trying to follow “nonaccommodating” monetary policies. In the baseline projection for 1984–86—critical because of the assumption that it is a Nash equilibrium—the authors assume “no dramatic change in policy.” (One difficulty in interpreting the results is that we are not told the specific settings of fiscal and monetary policy nor what happens to interest rates and exchange rates in the baseline, nor what happens to exchange rates in all the subsequent simulations.)

What happens if the three countries “cooperate” (MCM, table 12)? America is happy to do some monetary expansion as long as the others are prepared to do even more. This opens up scope for America to take *more* expansionary fiscal action since (a) this has virtually no inflation cost because it appreciates the dollar, and (b) America is completely indifferent to a deterioration in its current balance (table 9). Germany and Japan, however, apparently hate the loss of net exports resulting from their monetary expansion, which they therefore reduce by *more* fiscal restraint.

These results are—to put it mildly—counterintuitive. Nevertheless, at first sight they have a certain fascinating logic. Since these countries are assumed to be happy with their present policies, then perhaps they would be even happier if, cooperatively, they did more of the same—though since they are already doing it, uncooperatively, the additional benefits are small. A second look, however, suggests that in certain key respects the assumptions on which the whole analysis rests—that the models are “true” and the countries agree with this truth—do not hold.

Table 9 “reveals” that Japan is prepared to give up 5 percent of GNP for an increase in net exports equal to 1 percent of GNP, and that the

average shadow price for foreign exchange is 3.3 for Japan and Germany together. This is intriguing; we all suspect that others are mercantilist—but to *that* degree? After all, for any rational country in full (neoclassical) equilibrium, the shadow price should be one, and even with disequilibrium the weighted average for the system as a whole should still be one (as long as the supply of international liquidity is adequate). These implausibly high shadow prices emerge with impeccable logic from the following considerations: if countries are happy to pursue restrictive fiscal policies when (a) they have large and rising potential output gaps and (b) fiscal expansion is the least inflationary way of reducing these, it can be only because (c) fiscal expansion has the most adverse impact on net exports, to which, ergo, (d) they must attach very high disutility.

If told that this was their motivation, German and Japanese policy-makers would immediately respond that they have a quite different view of the “truth” about how fiscal policy works. Most explicitly for the Germans, they believe that fiscal restraint, while depressing output in the short run, will—because of improved confidence and “crowding in”—lead to higher output two or three years hence. If one substituted models with these properties, one would radically change not only the magnitude but also the sign of most of the results given in this paper. In particular, Germany and Japan would *not* react to U.S. fiscal restraint by doing the same (table 14); with less expansionary stimulus coming from America, they would logically impose *less* fiscal restraint because its short-term costs would rise relative to its perceived longer-term benefits.

Second, in one important respect the U.S. administration appears to be assuming the models are “true” when they are probably false. In the baseline America piles up about \$500 billion of public-sector debt and \$250 billion of external debt without, apparently, any rise in interest rates or decline in the dollar sufficient to matter. In an important section dealing explicitly with the longer-run consequences of debt accumulation, the authors point out that these longer-run effects may well go in the opposite direction. Many observers may well suspect that this could happen within the three years covered here, in which case the U.S. shadow price for foreign exchange would look very different. If so, America should take significant restrictive fiscal action (tables 14, 15, and 16), and for the reasons discussed above this should prompt expansionary fiscal action by Germany and Japan. Thus the authors’

dismissal of “conventional wisdom” on this subject is quite unfounded.

Third, as the authors note, current policymakers in all three countries appear to have very different views of the “truth” about inflation. In the models, 1 percent of GNP costs, on average, 0.2 percent in inflation. Since policymakers do not exploit this in the baseline, they are “revealed” to give inflation a shadow price of more than 4. This does not matter much in the scenarios discussed here, with their comfortably high growth rates. But if we get ourselves into a new recession, it clearly would matter a lot who is right.

Enough has been said to suggest that the authors have explored only the outer fringes of the fascinating and important new territory opened up by their pioneering efforts. A great deal remains to be done. In some ways the two models stand up quite well to the extremely heavy load put on them in this paper. But they will remain inappropriate for the use to which they are put here unless longer-term effects from accumulating debt and rising inflation are realistically spliced into their essentially short-term mechanisms. More work is also needed to explore the crucial relationship between policymakers’ revealed preference (and how this varies over time) and their (differing) views about how the world works. And from there, an effort should be made to move from revealed preference to a set of shadow prices that, while allowing for genuine national differences, provides a sensible and internationally consistent basis for macropolicy coordination.

Until this has been done it would be best if policymakers did not read this paper. It is true that in some ways it sheds fascinating light on how policymakers, starting from quite different views about how the world works, have got locked into the most divergent and internationally inconsistent mix of fiscal and monetary policies since the war. And why, temporarily, they are feeling quite happy about it. But since they are only likely to read the first few pages, they could very easily—but quite wrongly—conclude that it provides scientific justification for their folly.

Wing T. Woo: Gilles Oudiz and Jeffrey Sachs have written an extremely original paper on an important and timely topic. Its most important contribution is showing us an ingenious way of giving empirical content to theoretical propositions from game theory. Its most striking conclusion is that coordination does not help very much.

Within the authors’ framework, I interpret the gains from the trading

of macro policies—cooperation—as coming from altering the terms on which expansion must be traded against the current account and inflation. Independent policy actions amplify the effects on these two, whereas cooperative actions attenuate them. Thus, in exchange for the benefits of more expansion, any country incurs higher costs through a worsened current account and higher inflation if it acts alone rather than in cooperation with others. A recent example where the costs of such an independent policy course were large is provided by France; there the Mitterrand government was forced to drop its initial attempt to reflate on its own.

Going it alone is difficult for France because its economy is so intimately linked with the rest of Europe. When Oudiz and Sachs apply their methodology to quantifying the relations involving the United States, West Germany, and Japan, they find that the welfare gains of cooperation are small. Looking at tables 12 and 13, the gains are so small that we can conclude that they are not worth the costs involved in organizing and enforcing policy coordination. This suggests that policy coordination is a little like love: “all reason is against it but all healthy instinct is for it.” Being an unabashed romantic, I quickly note that the authors’ gains are small only because of the utility functions that they have pulled out via revealed preferences.

One important question is whether the Oudiz-Sachs utility weights are really those of the policymakers; two reasons why they may not be come quickly to mind. The first is that the models may be wrong. On this issue, although criticisms of large models rest on solid theoretical grounds, I agree with the authors that they offer useful, pragmatic answers, and the authors’ main conclusions appear to be similar with both their models. The second reason that the reported utility weights may not be those of policymakers is that the baseline may be a Stackelberg equilibrium rather than a Nash equilibrium. A case can be made that, since World War II, the United States has played the leadership role in the setting of macro policies within the major industrial countries, taking into account the reaction functions of the other countries in setting its own policies. If so, this would make the available trade-offs different and so would make the utility weights one infers from the data quite different from those the authors estimate.

In general, the simple characterization of national utility functions that the authors were forced to make in order to keep their analysis

tractable may have missed some important dimensions of the problem. For example, the welfare assessment of a change in the U.S. policy mix that is reported in table 16 does not address two important criticisms of the present policy mix of loose fiscal policy and tight monetary policy. The first criticism of the present policy mix focuses on the long run. High deficits crowd out investment and finally lead to a new steady state which has a lower capital-labor ratio. The second criticism pertains to middle-run considerations. Oudiz and Sachs point out in the first part of their paper that deficits are unsustainable when the real interest rate is higher than the growth rate. We take off on an unstable path along which, eventually, all taxes are used to pay interest. But the objectives of faster and sustainable economic growth are not in the authors' welfare function. A more complete analysis, I suspect, would show greater welfare gains to all parties.

The large negative utility weights on inflation that the authors find may reflect a dynamic aspect of policymaking that is not treated in this paper. The government may be engaged in a game within its own borders. In a situation where labor unions have market power and aim to improve the relative wage of their members, it may be better for a government to adopt a hard-line policy of nonaccommodation rather than either to accept inflation or attempt to contain it through a direct policy such as wage-price guideposts. This policy stance, which can be described as "you break it, you own it," forces unions to think in terms of a trade-off between higher wages and higher unemployment. With it, the government may believe it can produce a better trade-off than Oudiz and Sachs, or anyone else, can estimate from past data.

The authors have not addressed one important argument for policy coordination that is relevant within their utility framework. They assume that reactions of one country to another's policy will inevitably lead to stable equilibrium. But in a sequential decisionmaking process in which each country does not take into account the reaction of its neighbors, a stable outcome is not assured. The aggravation of the global depression in the 1930s caused by competitive devaluations is a case in point.

More also needs to be said about the problems of coordination. One such problem, which came out of the 1978 Bonn summit locomotive experience, is the need for optimal contingency plans. At the Bonn summit, the United States agreed to tighten its policies and to reduce oil imports in return for West German and Japanese commitments to raise

their annual growth rates by 1 percent and 1.5 percent, respectively. But six months later the shah of Iran was overthrown and Iranian oil production was drastically reduced. The resulting 50 percent rise in the price of oil was followed by the second OPEC price shock, which tripled oil prices in two years. Thus high inflation rates and large current account deficits in Germany and Japan came in the wake of the Bonn agreements. The experience left a negative feeling regarding coordination, which was evident in various statements issued just before the Williamsburg summit.

General Discussion

Robert Lawrence saw the study's main results as a plausible explanation for the lack of U.S. interest in policy coordination. In his work on the synchronization of the international business cycle, Lawrence had found that the direct linkages among countries accounted for only a small part of the synchronization. The synchronization of the cycle is largely explained by individual policies responding independently to common disturbances. He argued that the clamor for policy coordination has become the substitute for making difficult choices and said the Europeans should accept the responsibility for their own actions and the onus of mastering their own circumstances.

Other panelists questioned the realism of the authors' procedure for estimating welfare gains. Charles Schultze found the mechanical application of the revealed preference approach was inappropriate. He noted that even the Reagan administration now regarded the present U.S. policy mix as a mistake. The baseline used in most of the study should be seen as the outcome of ill-conceived actions rather than of deliberate optimizing behavior. James Duesenberry reasoned that extreme outcomes were not modeled correctly by the linear relationships assumed in the study. As an important example, the impact of current account deficits on foreigners' attitude toward dollar-denominated assets and hence on the value of the exchange rate was likely to be nonlinear. He concluded that the reaction of exchange markets to continued record current account deficits cannot be extrapolated from their present reaction, and the benefits of changing from present policies was probably greater than the model projected.

Paul Krugman added that limiting the analysis to the short-run effects

projected by the models might be misleading. As an example, the use of contractionary monetary policy to fight inflation through exchange rate appreciation might work over a short horizon but be self-defeating in the long run as the exchange rate depreciates to its former level when the economy returns to full employment. The inflationary impact of the depreciating exchange rate must be weighed against the earlier deflationary gains from appreciation. Sachs acknowledged that some effects might be modified or conceivably even reversed when looked at beyond the horizon of the model, as in Krugman's example. But he did not agree that the short-run welfare results would be overturned. With the quadratic loss function that was used, the welfare costs of a given exchange rate movement depend on the contemporaneous inflation rate. There would thus be a net welfare gain from appreciating the exchange rate when inflation is high and then allowing it to return to its former level when inflation is zero. More generally, Oudiz observed that what arguments were appropriate in the objective function depended on the time period of the analysis. It was possible to conceive of a long-run analysis and objective function. But this lay beyond the scope of present quantitative models and, possibly, beyond the interest of present policy-makers.