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INTERNATIONAL MACROECONOMIC POLICY COORDINATION WHEN POLICY-MAKERS DISAGREE ON THE MODEL

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ABSTRACT

The existing literature on international macroeconomic policy coordination makes the unrealistic assumption that policy-makers all know the true model, from which it follows in general that the Nash bargaining solution is superior to the Nash non-cooperative solution. But everything changes once we recognize that policy-makers' models differ from each other and therefore from the "true" model. It is still true that the two countries will in general be able to agree on a cooperative policy package that each believes will improve the objective function relative to the Nash non-cooperative solution. However, the bargaining solution is as likely to move the target variables in the wrong direction as in the right direction, in the light of a third true model.

This paper illustrates these theoretical points with monetary and fiscal multipliers taken from simulations of eight leading international econometric models. (It is a sequel to NBER Working Paper 1925, which considered coordination between the domestic monetary and fiscal authorities.) Here we first consider coordination between U.S. and non-U.S. central banks. We find that out of 512 possible combinations of models that could represent U.S. beliefs, non-U.S. beliefs and the true model, coordination improves U.S. welfare in only 289 cases, reducing it in 206, and improves the welfare of other OECD countries in only 297 cases, reducing it in 198. Then we consider coordination with both monetary and fiscal policy. We find that out of 512 combinations, coordination improves U.S. welfare in 183 cases, reducing it in 228, and improves the welfare of other OECD countries in 283 cases, reducing it in 219. A final section of the paper considers possible extensions of the framework, dealing with uncertainty.

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International policy coordination has been the fastest-growing research topic in the field of open-economy macroeconomics.[1] The topic owes its success to the happy marriage of the mathematical techniques of game theory and the practical problem of coordination that has in the mid-1980s become of central concern to international policy-makers. Virtually all of the coordination literature has made the automatic assumption that policy-makers agree on the true model of how the world macroeconomy behaves. As a consequence, it has reached a very strong conclusion: in general, countries will be better off it they coordinate policies than they would be in the Nash non-cooperative equilibrium in which each government sets its policies while taking those of the others as given.[2] The empirical literature is as yet less fully developed than the theoretical literature. But it too has claimed gains from coordination that, though small, are necessarily positive.[3] If the case in favor of coordination is indeed this clear, one might wonder at the stupidity of governments in not pursuing it more seriously.

The assumption that policy-makers agree on the true model has little, if any, empirical basis. Different governments subscribe to different economic philosophies. If one wishes to think of actors as perpetually processing new information in a Bayesian manner, so that their models over time would converge on any given reality in the limit, then one must admit that the speed of convergence is sufficiently slow, or else that reality is changing sufficiently rapidly, that policy-makers have not been able to reach agreement on the true model. Nor is there much prospect of them doing so in the foreseeable future.

Professional economists are not much more able to agree on the correct macroeconomic model than are policy-makers. A concrete illustration was offered by a recent exercise at the Brookings Institution. Ralph Bryant and Dale Henderson asked those responsible for twelve leading econometric models of the world economy to simulate the effects of some carefully-specified policy changes.[4] The predictions of the models varied widely as to both the magnitude and the sign of the effects on output, inflation, exchange rates and current account balances among trading partners and even in the country originating the policy change. (See tables 1 and 6 below.) Obviously no more than one of the models can be right, and it seems unlikely that even one of them is in fact exactly right.

Lack of knowledge as to the true model helps explain a troublesome fact. While support for the proposition that coordination would improve welfare is widespread, proponents do not generally agree on the nature of the Pareto-improving package of policy changes that is called for in any particular set of circumstances. Some call for coordinated expansion, some for coordinated discipline, some for coordinated shifts in the mix between monetary and fiscal policy, and so forth.[5] Obviously if one sort of package would raise welfare, then others would lower welfare. Disagreement, even within one country, as to where the economy currently sits relative to the desired values of the target variables is responsible for some of the disagreement on the desirable coordinated policy changes, but disagreement as to the correct model is also a significant factor. As Branson (1986, 176) says, "With this range of disagreement on economic analysis, how are the negotiators to reach agreement? The topic is one for the National Science Foundation, not a new Bretton Woods."

One implication of the lack of agreement on the true model is, of course, that "more research needs to be done." But the implications for any policy coordination that might take place in the meantime are considerably more interesting. This paper demonstrates two propositions that hold when policy-makers disagree on the model. First, in contrast to what one might think before careful reflection, such policy-makers will in general be able to find a package of coordinated policy changes that each believes will improve its country's welfare relative to the sub-optimal Nash noncooperative equilibrium.[6] Second, and in striking contrast to the standard result when policy-makers agree on the model, the package of coordinated policy changes could turn out to reduce welfare, as judged by some true model of reality, as easily as raise it. For example, using eight models from the Brookings simulations as models which could represent the views of the U.S. government, the views of other industrialized countries, or the true world macroeconomy, we find that out of 512 possible combinations, monetary coordination perceptibly improves U.S. welfare in only 289 cases, reducing it in 206 cases, and improves the welfare of the other industrialized countries in only 297 cases, reducing it in 198.

The first two sections of the paper analyze a very simple game where two countries, the United States and Europe, must decide how to set their money supplies so as to come as close as possible to their desired levels of two target variables: income and the current account (internal balance and external balance). Section 1 makes the two points theoretically, that the two central banks will in general be able to agree on a coordinated policy package that each thinks leaves its country in a better position, and that the package might in fact leave them in a worse position. Section 2 uses the multipliers from the eight models in the Brookings simulations to provide a dramatic illustration of the points.

In section 3 each government is given a second policy instrument, government expenditure, to use, in addition to monetary policy, and a third target variable, inflation, to pursue in addition to income and the current account. Again we see that the governments will in general find a coordinated policy package that they expect to improve welfare, but that it could as easily have the opposite effect in reality. Section 4 considers extensions of the framework to deal with the policy-maker's uncertainty regarding the true model, or the other player's model, or both.

Section 1: The Theory of Monetary Coordination with Disagreement

Here we assume that each country is interested in two target variables: its own output, denoted y for the United States and y^* for Europe (expressed relative to their optimum values and in log form), and its current account balance, denoted x and x^* respectively (expressed as a percentage of GNP and again relative to their optimums). Each government seeks to minimize a quadratic loss function.

(1) $W = y^2 + \omega x^2$

(2) $W^* = y^{*2} + \omega^* x^{*2}$

where ω and ω^* denote the relative weights placed on external balance versus internal balance.

We assume a general framework in which the targets are linearly related to the available policy instruments, which in this section are limited to the countries' money supplies, m and m^* respectively (in log form). We denote the parameters as perceived by the U.S. authorities by a "us" subscript.

(3) $y = A_{us} + C_{us} m + E_{us} m^*$

(4) $x = B_{us} + D_{us} m + F_{us} m^*$

We denote the parameters perceived by the European government by an "e" subscript.

(5) $y^* = G_e + I_e m + K_e m^*$

(6) $x^* = H_e + J_e m + L_e m^*$

Since each country has only a single instrument but two targets, it cannot unilaterally achieve its targets. We begin by considering the Nash non-cooperative equilibrium. To ascertain U.S.

behavior we differentiate (1) with respect to m, using (3) and (4) and holding m^* constant. It follows that the U.S. reaction function is:

(7) $m = M + N m^*$,

where $$M = -\frac{A_{us} C_{us} + \omega B_{us} D_{us}}{C_{us}^2 + \omega D_{us}^2}$$

and $$N = -\frac{E_{us} C_{us} + \omega F_{us} D_{us}}{C_{us}^2 + \omega D_{us}^2} .$$

To ascertain European behavior we differentiate (2) with respect to m^*, using (5) and (6) and holding m constant. The European reaction function is:

(8) $m^* = Q + Rm$,

where $$Q = -\frac{G_e K_e + \omega^* H_e L_e}{K_e^2 + \omega^* L_e^2}$$

and $$R = -\frac{I_e K_e + \omega^* J_e L_e}{K_e^2 + \omega^* L_e^2} .$$

We solve equations (7) and (8) for the Nash equilibrium.

(9) $$m^n = \frac{M + NQ}{1 - NR}$$

(10) $$m^{*n} = \frac{Q + MR}{1-NR}$$

Figure 1 shows the two policy-makers' reaction functions, equations (7) and (8). The optimum point as perceived by the U.S. policy-makers is a point O_{us} on its reaction function. Concentric indifference curves radiate from O_{us}. These curves are vertical

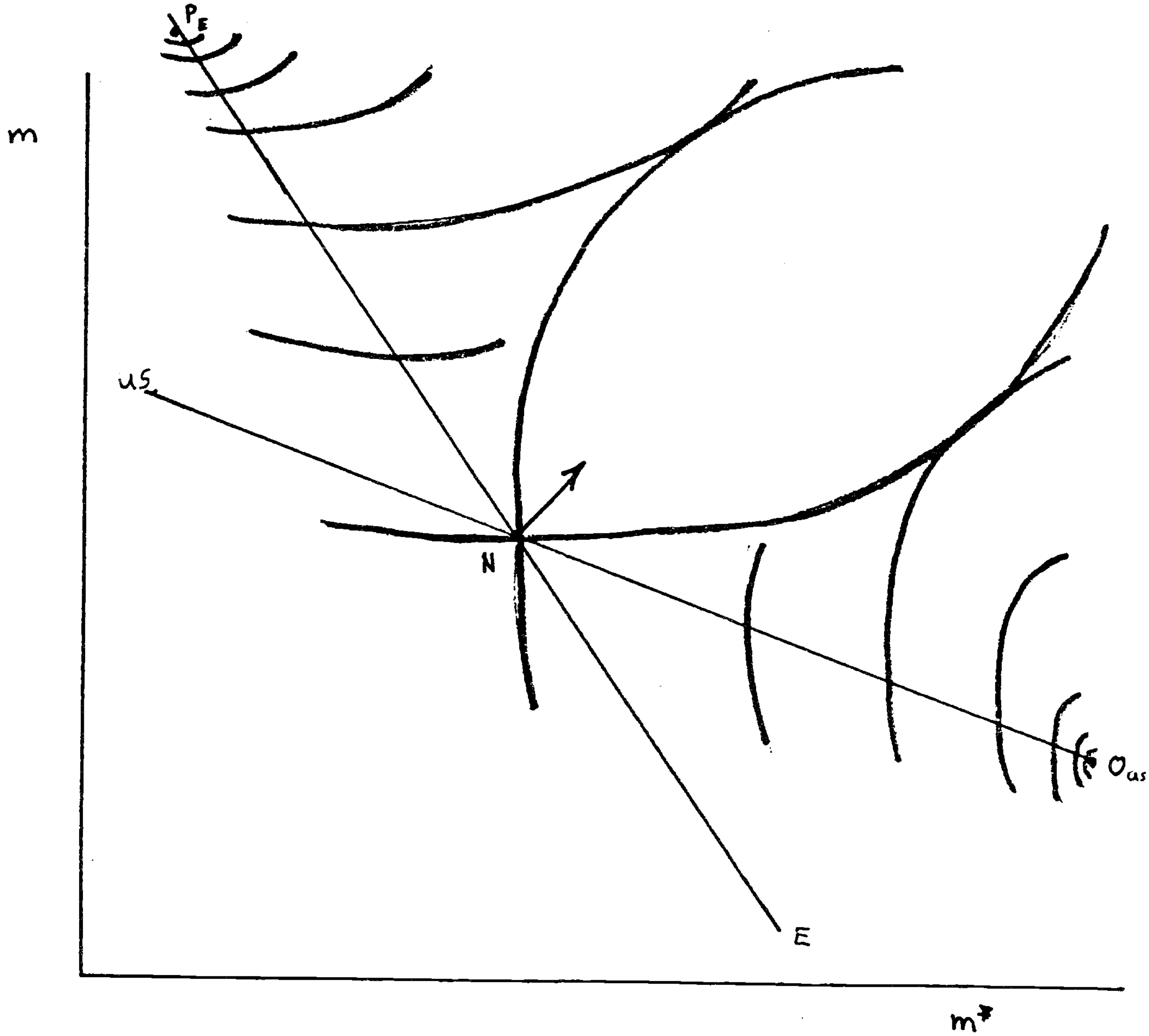

Figure 1

wherever they intersect the reaction function, because m is chosen so that its marginal benefit given m^* is zero. Similarly the optimum point as perceived by the European policy-maker is a point P_E, and its concentric indifference curves are horizontal wherever they intersect its reaction function.

We have drawn the European reaction curve as steeper than the U.S. curve. One might expect that the effects that are largest in absolute value are the positive effects of money on domestic output: C in equations (3) - (4) for the United States and K in equations (5)-(6) for the non-U.S. OECD.[7] It follows that, unless the welfare weight ω on the current account is large, the absolute value of the slope of the U.S. reaction function is less than one when the U.S. money supply is on the vertical axis, and vice versa for the European reaction function.

The possibilities for the sign of the slope are more diverse. If monetary expansion is thought to be transmitted negatively to trading partners ($E < 0$), presumably via a depreciation of the currency and improvement in the trade balance of the expanding country as in the Mundell-Fleming model, then the slope is positive: $N > 0$. If monetary transmission is thought to be positive on the other hand ($E > 0$), then the slope is ambiguous: when the welfare weight ω on the current account is small, the slope is negative, but when ω is large, or when the transmission multiplier E is small (relative not only to the own multiplier C, but also to the current account multipliers D and F), the slope is again positive. (We are assuming that D and F, the effects of m and m^* on the domestic current account, are of opposite signs by symmetry.)

The same analysis holds for the foreign reaction function (e.g., $I < 0 \Rightarrow R > 0$), though it must be remembered that even if any given model is symmetric, the two reaction functions could easily have opposite slopes. For example one country might believe that transmission is negative and the other that it is positive. In figure 1 we have drawn the functions downward-sloping: a foreign expansion is transmitted positively to the domestic country and so the domestic government reacts by contracting.

The Nash equilibrium N is determined as the intersection of the two reaction functions. At N the indifference curves cannot be tangent, but must intersect, since their respective slopes are infinity and zero. It follows that the Nash equilibrium is perceived as Pareto-inefficient. Both policy-makers think they would be better off if they could agree to move to a point within the "lens" determined by the intersection of the two indifference curves.

As we have drawn the graph, each country would like to expand but is afraid to do so on its own, presumably because of adverse implications for the current account. But they can agree to expand simultaneously, moving northeastward in the graph to higher levels of perceived welfare. Such joint reflation is the kind of international coordination that has been urged on Germany and Japan by the United States under two different Administrations: in 1977-78, in the form of the "locomotive theory," and in 1986 in the form of coordinated discount rate cuts.[8]

If an efficient mechanism of coordination exists, the countries will move, not just northeastward, but specifically to one of the points on the contract curve, where the two countries' indifference curves are tangent. There is no strong reason to choose any particular point. Nor, for that matter, is there reason to think that any Pareto-improving solution can necessarily be enforced. But we follow much of the literature in considering the Nash bargaining solution, defined as the point where the product of the two countries' perceived welfare gains, compared to the perceived welfare at the Nash noncooperative solution, is maximized:

$$(11) \quad \text{Max} \quad \left(W_{us}(m, m^*) - W_{us}(m^n, m^{*n})\right)\left(W_e^*(m,m^*) - W_e(m^n, m^{*n})\right)$$

$$= \left(\left[(A_{us} + C_{us}\, m + E_{us}\, m^*)^2 + \omega\,(B_{us} + D_{us}\, m + F_{us}\, m^*)^2\right]\right.$$

$$\left. - \left[(A_{us} + C_{us}\, m^n + E_{us}\, m^{*n})^2 + \omega\,(B_{us} + D_{us}\, m^n + F_{us}\, m^{*n})^2\right]\right)$$

$$\left((G_e + I_e\, m + K_e\, m^*)^2 + \omega^*\,(H_e + J_e\, m + L_e\, m^*)^2\right]$$

$$- \left[(G_e + I_e\, m^n + K_e\, m^{*n})^2 + \omega^*\,(H_e + J_e\, m^n + L_e\, m^{*n})^2\right]\Big) \quad .$$

One would differentiate with respect to m and m^* to find the bargaining solution (m^b, m^{*b}), a point such as B in figure 2.

Once we recognize that the two policy-makers have different models of the world, we must recognize that one, or both, will be wrong.

To evaluate whether the bargaining solution B is superior to the noncooperative solution (m^n, m^{*n}) not just in perception but also in reality, we would have to know the true parameter values, the output and current account functions (3)-(6) without the subscripts:

(12) $y = A + C\ m + E\ m^*$

(13) $x = B + D\ m + F\ m^*$

(14) $y^* = G + I\ m + K\ m^*$

(15) $x^* = H + J\ m + L\ m^*$

We would then plug m^b and m^{*b} into (12)-(15), and in turn plug the target variables into the loss functions (1) and (2), to see whether the bargaining solution in fact improves welfare.

In the standard case where the policy-makers agree on the correct model, coordination must necessarily improve welfare for each country, or else its government would not have agreed to go along. In our case, coordination <u>may</u> improve welfare. For example if the true model is very close to that believed by the U.S. authorities, then the true iso-welfare map will be very similar to the perceived indifference curves shown in figure 1, and U.S. welfare will indeed be higher at B than N. But this need not be the case.

The true optimum policy combination to maximize U.S. welfare is given by differentiating (1) with respect to m (as in the derivation of (7) but without the subscripts), and with respect to m^*, and solving simultaneously:

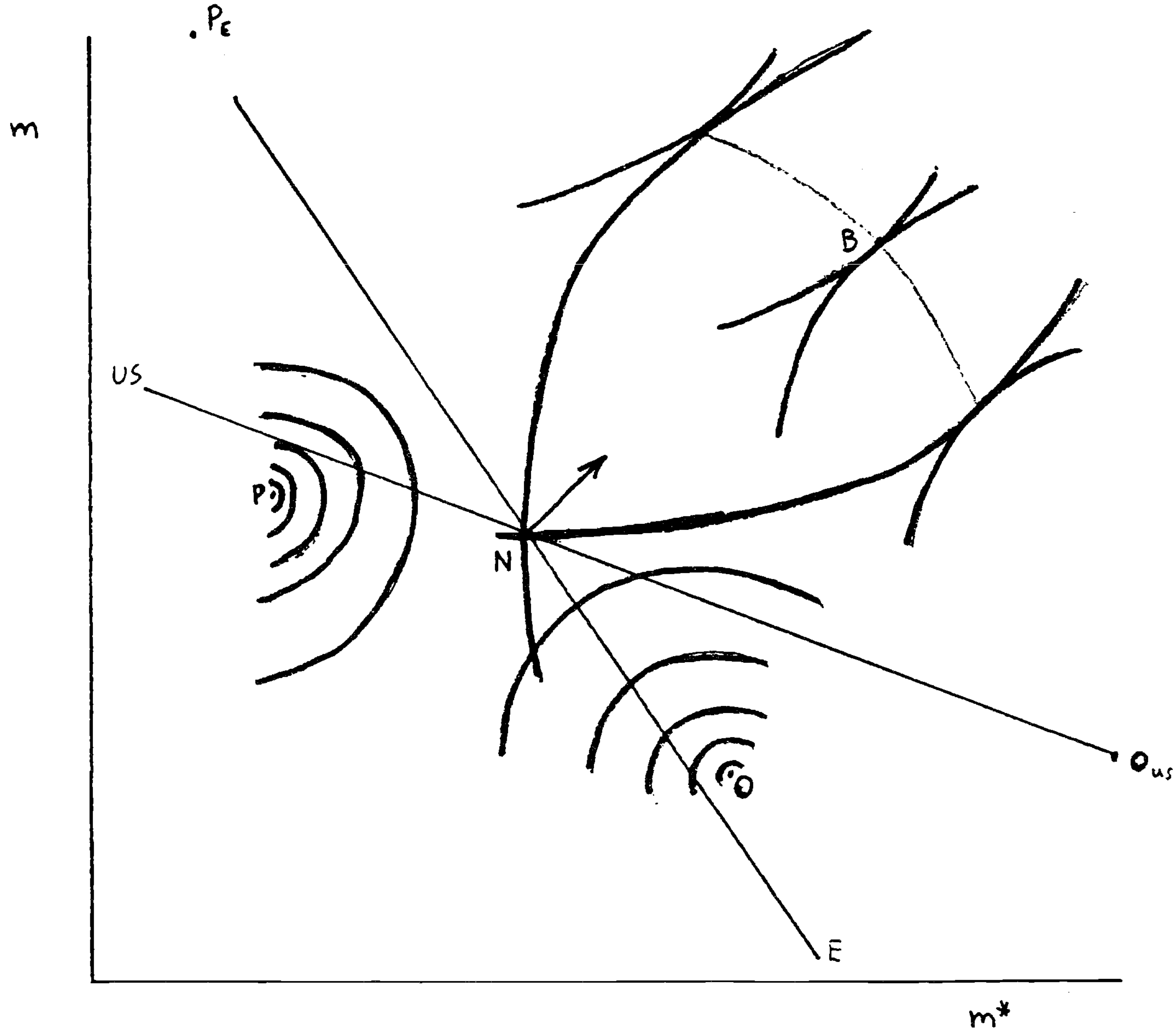

Figure 2

$$(10) \quad m^{o} = \frac{M\,(E^2 + \omega F^2) - N\,(AE + \omega BF)}{(E^2 + \omega F^2) + N\,(CE + \omega DF)}$$

$$(11) \quad m^{*o} = - \frac{AE + \omega BF}{E^2 + WF^2} - \frac{CE + \omega DF}{E^2 + \omega F^2}\, m^{o}$$

If the true optimum point O is not at O_{us} but rather is as shown in Figure 2, with the new set of true iso-welfare curves drawn, then the move from N to B could very well be in the wrong direction, resulting in a reduction in U.S. welfare. Similarly if the true optimum policy combination from the viewpoint of European interests is not at P_e but rather at P as shown in Figure 2, then coordination could reduce European welfare as well.

It is worth considering momentarily the case when the two policy-makers are seeking to maximize the identical objective function, and disagree <u>only</u> about the proper model. For example they might be the monetary and fiscal authority within the same country. Our two propositions would still hold: (1) the two policy-makers will in general be able to agree on a package of coordinated policy changes that each thinks will improve the (same) country's welfare relative to the Nash noncooperative solution, and (2) the package agreed to in bargaining could in fact worsen welfare as easily as improve it. This is the case considered in Frankel (1986b).[9] While in that paper coordination arises solely from different perceptions, and in the conventional literature it arises solely from different objectives, in the present paper both factors are present.

Section 2: Coordination with Eight International Econometric Models

How important for coordination is the issue of conflicting models likely to be in practice? Is the case where bargaining reduces welfare as judged by the true model merely a pathological counterexample, or is it a likely occurrence? In what follows we use the international simulation results of the macro-econometric models that participated in the Brookings exercise to get an idea of what might actually happen if governments coordinate.

The models were asked to show the effects of four experiments, among others: an increase in the U.S. money supply, an increase in the non-U.S. OECD money supply, an increase in U.S. government expenditure and an increase in non-U.S. OECD government expenditure. In each case the instructions were to hold the other policy instruments constant. Though twelve models participated, some did not report effects on current account balances, which we need along with effects on output levels. The eight that we can use here are the Federal Reserve Board's Multi-Country Model (MCM), Patrick Minford's Liverpool Model (LIVPL), the Sims-Litterman Vector AutoRegression Model (VAR), the OECD's Interlink Model (OECD), the Project Link Model (LINK), the McKibbon-Sachs Global Model (MSG), the EEC Commission's Compact Model (EEC), and the Haas-Masson smaller approximation of the MCM model (MINIMOD). These models are quite representative of the range of econometric models actually in use, including as they do models both large and small in size, structural and nonstructural in approach, Keynesian and neoclassical in philosophy, backward-looking and

Table 1a: Monetary Policy

Simulation Effect in Second Year of Increase in Money Supply (4 Percent)

	Y	CPI	i (pts.)	Currency Value	CA ($b)	CA* ($b)	i* (pts.)	CPI*	Y*
Monetary Expansion in U.S. (Sim. D)	Effect in U.S.					Effect in Non-U.S.			
MCM	+1.5%	+0.4%	-2.2	-6.0%	-3.1	-3.5	-0.5	-0.6%	-0.7%
EEC 1/	+1.0%	+0.8%	-2.4	-4.0%	-2.8	+1.2	-0.5	-0.4%	+0.2%
EPA 2/	+1.2%	+1.0%	-2.2	-6.4%	-1.6	-10.1	-0.6	-0.5%	-0.4%
LINK	+1.0%	-0.4%	-1.4	-2.3%	-5.9	+1.5	NA	-0.1%	-0.1%
Liverpool	+0.1%	+3.7%	-0.3	-3.9%	-13.0	+0.1	-0.1	-0.0%	-0.0%
MSG	+0.3%	+1.5%	-0.8	-2.0%	+2.6	-4.4	-1.2	-0.7%	+0.4%
MINIMOD	+1.0%	+0.8%	-1.8	-5.7%	+2.8	-4.7	-0.1	-0.2%	-0.2%
VAR 3/	+3.0%	+0.4%	-1.9	-22.9%	+4.9	+5.1	+0.3	+0.1%	+0.4%
OECD	+1.6%	+0.7%	-0.8	-2.6%	-8.4	+3.1	-0.1	-0.1%	+0.3%
Taylor 3/	+0.6%	+1.2%	-0.4	-4.9%	NA	NA	-0.1	-0.2%	-0.2%
Wharton	+0.7%	+0.0%	-2.1	-1.0%	-5.1	+5.3	-1.3	-0.1%	+0.4%
DRI	+1.8%	+0.4%	-2.3	-14.6%	-1.4	+14.5	-1.1	-1.3%	-0.6%
Monetary Expansion in Non-U.S. OECD (Sim. H)	Effect in Non-U.S.					Effect in U.S.			
MCM	+1.5%	+0.6%	-2.1	-5.4%	+3.5	+0.1	-0.2	-0.2%	-0.0%
EEC 1/	+0.8%	+1.0%	-1.0	-2.3%	-5.2	+1.9	+0.0	+0.1%	+0.1%
EPA 2/	+0.0%	+0.0%	-0.1	-0.1%	-0.1	+0.1	-0.0	-0.0%	+0.0%
Link 4/	+0.8%	-0.6%	NA	-2.3%	-1.4	+3.5	+0.0	-0.0%	+0.1%
Liverpool	+0.4%	+2.8%	-0.9	-8.4%	+7.1	-8.2	-1.1	-3.4%	+1.6%
MSG	+0.2%	+1.5%	-0.7	-1.4%	-15.9	+12.0	-1.2	-0.6%	+0.3%
MINIMOD	+0.8%	+0.2%	-1.8	-4.8%	+3.6	-1.4	-0.6	-0.5%	-0.3%
VAR 3/	+0.7%	-0.5%	-3.0	-5.5%	+5.2	-10.0	+0.6	-0.7%	+1.2%
OECD	+0.8%	+0.3%	-1.3	-2.1%	-1.6	+2.3	-0.2	-0.1%	+0.1%
Taylor 3/	+0.8%	+0.7%	-0.3	-3.5%	NA	NA	-0.2	-0.5%	-0.1%
Wharton	+0.2%	-0.1%	-0.8	+0.2%	+2.6	+0.5	+0.0	+0.0%	+0.0%
DRI	NA	NA	NA	NA	NA	NA	NA	NA	NA

1/ Non-U.S. short-term interest rate NA; long-term reported instead.

2/ Non-U.S. current account is Japan, Germany, the United Kingdom, and Canada.
3/ CPI NA. GNP deflator reported instead
4/ Appreciation of non-U.S. currency NA; depreciation of dollar reported instead

Table 1. Monetary Multipliers

(For two targets in each country)

	Percentage Effect on Income		Effect on Current Account (As Percentage of GNP):	
From a (1 percent) increase in:	U.S. m	Eur. m	U.S. m	Eur. m
Effect on U.S.	(C)	(E)	(D)	(F)
MCM	0.3750	0.0000	-0.0198	0.0006
Liverpool	0.0250	0.4000	-0.0832	-0.0525
VAR	0.7500	0.3000	0.0311	-0.0634
OECD	0.4000	0.0250	-0.0537	0.0147
LINK	0.2500	0.0250	-0.0380	0.0225
MSG	0.0750	0.0750	0.0167	0.0769
EEC	0.2500	0.0250	-0.0180	0.0122
MINIMOD	0.2500	-0.0750	0.0179	-0.0089
Effect on non-U.S. OECD ("Europe")	(I)	(K)	(J)	(L)
MCM	-0.1750	0.3750	-0.0090	0.0090
Liverpool	0.0000	0.1000	0.0034	0.2384
VAR	0.1000	0.1750	0.1169	0.1192
OECD	0.0750	0.2000	0.0178	-0.0091
LINK	-0.0250	0.2000	0.0083	-0.0077
MSG	0.1000	0.0500	-0.0206	-0.0743
EEC	0.0500	0.2000	0.0159	-0.0689
MINIMOD	-0.0500	0.2000	-0.0226	0.0173

forward-looking in expectations formation, European and American in authorship, and public-sector and private-sector in function.

Table 1a reports the effects of monetary expansion on several macroeconomic variables. The simulations showed effects over six years, but ours is a static framework; we use only the effect in the second year. (Two years is intended to be just long enough to get past the negative part of the "J-curve effect" of the exchange rate on the trade balance.) Table 1 reports the multipliers for output and the current account calculated in the form that we need: as a percentage of GNP per one percent change in the money supply. The models all agree that a monetary expansion raises domestic output, but they agree on little else. There is a surprising amount of disagreement, in particular, on whether a monetary expansion improves or worsens the current account and, in turn, on whether it is transmitted negatively or positively to the rest of the world. The reasons for this and other disagreements in the simulations are examined elsewhere.[10] It suffices to repeat that disagreements with respect to both the sign and magnitude of effects are common among honorable economists, and are common even within subsets of models that are supposedly similar in orientation, let alone among policy-makers.

Computing the policy-makers' reactions requires knowing not only the perceived policy multipliers, but also the target optimums and the welfare weights. We adopt the same target values as Oudiz and Sachs (1984): current accounts of zero for the United States and two percent of GNP for the non-U.S. OECD, and GNP gaps of zero for both regions. The baseline values of both variables, specified as part of the

Brookings simulation exercise, were below target as of 1985. Thus policy-makers will seek to increase both output and the current account. The targets, together with the baseline values for the variables and any set of policy multipliers from Table 1, imply corresponding values for the constant terms A, B, G and H in equations (3)-(6).

The choice of welfare weights ω and ω^* is necessarily more arbitrary, even, than the choice of target optimums. Oudiz and Sachs chose the values that the weights would have had to have held for countries to have produced the values of output, inflation and the current account actually observed in the 1980s, assuming a Nash non-cooperative equilibrium. For lack of a better alternative, we adopt the set of weights calculated by Oudiz and Sachs for the EPA model, and apply it uniformly regardless of model. We do not replicate their methodology separately with each model, because our welfare comparisons require a common objective function. But we have examined the sensitivity of our results to different welfare weights, and to different optimum values for the targets as well; we found no qualitative change in the results.[11]

If the U.S. policy-maker can believe any of the eight models and the non-U.S. (henceforth "European") policy-maker can believe any of the eight models, then there are 8 x 8 = 64 possible combinations, each implying a different Nash non-cooperative equilibrium. In Table 2 we report 6 x 6 = 36 of them. (8 x 8 is a bit too unwieldly for one table.)

Table 2: Nash Non-cooperative Equilibrium (Monetary Policies)

MODEL SUBSCRIBED TO BY THE UNITED STATES	MODEL SUBSCRIBED TO BY EUROPE					
	MCM	LIVPOOL	VAR	OECD	LINK	MSG
MCM						
NASH POINT: STABLE?	YES	YES	YES	YES	YES	YES
STEPS	1	1	1	1	1	1
DEVIATION OF NASH FROM BASELINE						
M_e	34.642	-6.150	-59.320	46.065	52.775	-10.020
M_{us}	10.547	10.523	10.492	10.554	10.558	10.521
PERCEIVED DEVIATION OF TARGET FROM BASELINE						
EUR. Y	11.145	-0.615	-9.332	10.004	10.291	0.551
CA	0.216	-1.431	-5.846	-0.232	-0.321	0.528
US Y	3.955	3.946	3.934	3.958	3.959	3.945
CA	-0.187	-0.212	-0.246	-0.180	-0.175	-0.215
PERCEIVED DEVIATION OF TARGET FROM GOAL						
EUR. Y	0.445	-11.315	-20.032	-0.696	-0.409	-10.149
CA	-1.397	0.356	2.206	-1.151	-0.792	-0.512
US Y	-1.015	-1.024	-1.036	-1.012	-1.011	-1.025
CA	-2.863	-2.888	-2.922	-2.856	-2.851	-2.891
PERCEIVED GAIN FOR:						
EUR.	1.2296	0.2733	5.1246	1.0760	1.0891	0.2243
US	0.1673	0.1572	0.1440	0.1701	0.1717	0.1563
LIVPOOL						
NASH POINT: STABLE?	YES	YES	YES	YES	YES	YES
STEPS	7	3	99	6	5	6
DEVIATION OF NASH FROM BASELINE						
M_e	-0.721	-5.158	46.319	94.535	37.419	21.077
M_{us}	-64.582	-60.877	-103.859	-144.120	-96.428	-82.782
PERCEIVED DEVIATION OF TARGET FROM BASELINE						
EUR. Y	11.031	-0.516	-2.280	8.098	9.894	-7.224
CA	0.572	-1.434	-6.622	-3.388	-1.090	0.136
US Y	-1.903	-3.585	15.931	34.211	12.557	6.361
CA	5.409	5.333	6.208	7.027	6.057	5.779
PERCEIVED DEVIATION OF TARGET FROM GOAL						
EUR. Y	0.331	-11.216	-12.980	-2.602	-0.806	-17.924
CA	-1.041	0.353	1.429	-4.307	-1.561	-0.904
US Y	-6.873	-8.555	10.961	29.241	7.587	1.391
CA	-0.308	-0.383	0.491	1.310	0.340	0.062
PERCEIVED GAIN FOR:						
EUR.	1.3462	0.2959	7.8288	-1.2830	0.8432	-2.0326
US	1.9511	1.6981	1.2223	-6.2256	1.9365	2.4202
VAR						
NASH POINT: STABLE?	YES	YES	YES	YES	YES	YES
STEPS	4	2	5	3	3	3
DEVIATION OF NASH FROM BASELINE						
M_e	28.280	-6.141	-86.278	53.211	49.689	-10.311
M_{us}	-2.970	9.843	39.673	-12.250	-10.939	11.395
PERCEIVED DEVIATION OF TARGET FROM BASELINE						
EUR. Y	11.125	-0.614	-11.131	9.723	10.211	0.624
CA	0.280	-1.431	-5.647	-0.697	-0.475	0.532
US Y	6.256	5.540	3.871	6.776	6.702	5.453
CA	-1.885	0.695	6.700	-3.753	-3.489	1.007
PERCEIVED DEVIATION OF TARGET FROM GOAL						
EUR. Y	0.425	-11.314	-21.831	-0.977	-0.489	-10.076
CA	-1.333	0.356	2.404	-1.617	-0.947	-0.508
US Y	1.286	0.570	-1.099	1.806	1.732	0.483
CA	-4.630	-2.051	3.955	-6.499	-6.235	-1.738
PERCEIVED GAIN FOR:						
EUR.	1.2531	0.2735	4.2495	0.8996	1.0526	0.2395
US	-0.7022	0.4674	-0.3087	-2.1134	-1.8854	0.5478

(cont.)

Table 2 (cont.)

MODEL SUBSCRIBED TO BY THE UNITED STATES	MODEL SUBSCRIBED TO BY EUROPE					
	MCM	LIVPOOL	VAR	OECD	LINK	MSG
OECD						
NASH POINT: STABLE?	YES	YES	YES	YES	YES	YES
STEPS	2	2	2	2	2	2
DEVIATION OF NASH FROM BASELINE						
M_e	31.615	-6.075	-55.545	48.219	51.774	-8.234
M_{us}	4.116	5.106	6.405	3.679	3.586	5.162
PERCEIVED DEVIATION OF TARGET FROM BASELINE						
EUR. Y	11.135	-0.608	-9.080	9.920	10.265	0.105
CA	0.246	-1.431	-5.873	-0.372	-0.371	0.506
US Y	2.437	1.890	1.174	2.677	2.729	1.859
CA	0.244	-0.363	-1.160	0.511	0.568	-0.398
PERCEIVED DEVIATION OF TARGET FROM GOAL						
EUR. Y	0.435	-11.308	-19.780	-0.780	-0.435	-10.595
CA	-1.366	0.356	2.173	-1.292	-0.842	-0.535
US Y	-2.533	-3.080	-3.796	-2.293	-2.241	-3.111
CA	-2.815	-3.422	-4.218	-2.547	-2.490	-3.456
PERCEIVED GAIN FOR:						
EUR.	1.2409	0.2750	5.2412	1.0291	1.0780	0.1285
US	0.2788	-0.0057	-0.4833	0.3866	0.4033	-0.0237
LINK						
NASH POINT: STABLE?	YES	YES	YES	YES	YES	YES
STEPS	1	1	1	2	2	1
DEVIATION OF NASH FROM BASELINE						
M_e	32.133	-6.080	-55.023	47.772	51.988	-8.348
M_{us}	5.218	5.490	5.840	5.106	5.076	5.507
PERCEIVED DEVIATION OF TARGET FROM BASELINE						
EUR. Y	11.137	-0.608	-9.045	9.937	10.271	0.133
CA	0.241	-1.431	-5.877	-0.343	-0.360	0.507
US Y	2.108	1.221	0.084	2.471	2.569	1.168
CA	0.525	-0.345	-1.461	0.882	0.978	-0.397
PERCEIVED DEVIATION OF TARGET FROM GOAL						
EUR. Y	0.437	-11.308	-19.745	-0.763	-0.429	-10.567
CA	-1.372	0.356	2.174	-1.262	-0.832	-0.533
US Y	-2.862	-3.749	-4.886	-2.499	-2.401	-3.802
CA	-2.810	-3.680	-4.796	-2.453	-2.357	-3.732
PERCEIVED GAIN FOR:						
EUR.	1.2390	0.2749	5.2572	1.0392	1.0804	0.1348
US	0.3817	-0.0561	-0.7885	0.5271	0.5629	-0.0858
MSG						
NASH POINT: STABLE?	YES	YES	NO	YES	YES	YES
STEPS	99	3	99	12	6	11
DEVIATION OF NASH FROM BASELINE						
M_e	38.815	-7.497	179.648	49.873	50.782	-102.426
M_{us}	19.413	107.410	-248.185	-1.598	-3.326	287.785
PERCEIVED DEVIATION OF TARGET FROM BASELINE						
EUR. Y	11.158	-0.750	6.620	9.855	10.240	23.657
CA	0.174	-1.426	-7.602	-0.480	-0.421	1.694
US Y	4.367	7.493	-5.140	3.621	3.559	13.902
CA	3.310	1.214	9.685	3.811	3.852	-3.083
PERCEIVED DEVIATION OF TARGET FROM GOAL						
EUR. Y	0.458	-11.450	-4.080	-0.845	-0.460	12.957
CA	-1.439	0.360	0.449	-1.399	-0.892	0.654
US Y	-0.603	2.523	-10.110	-1.349	-1.411	8.932
CA	0.404	-1.692	6.779	0.905	0.946	-5.989
PERCEIVED GAIN FOR:						
EUR.	1.2135	0.2422	9.5926	0.9894	1.0663	-0.4466
US	0.7989	0.5578	-3.2922	0.7404	0.7336	-2.3909

* 99 INDICATES MORE THAN 20 STEPS REQUIRED FOR CONVERGENCE

Table 3: Bargaining Solution

(Movement from Non-cooperative to Cooperative Solution)

MODEL SUBSCRIBED TO BY THE UNITED STATES	MODEL SUBSCRIBED TO BY EUROPE					
	MCM	LIVPOOL	VAR	OECD	LINK	MSG
MCM						
BARGAINING CHANGE IN POLICY						
M_e	0.228	0.000	2.003	1.593	0.727	2.074
M_{us}	-0.142	0.000	-0.433	0.364	0.247	0.420
PERCEIVED CHANGE IN TARGETS						
EUR. Y	0.110	0.000	0.307	0.346	0.139	0.146
CA	0.003	0.000	0.183	-0.008	-0.004	-0.163
US Y	-0.053	0.000	-0.163	0.137	0.092	0.153
CA	0.003	0.000	0.010	-0.006	-0.004	-0.007
PERCEIVED GAIN FOR:						
EUR.	0.0001	0.0000	0.0068	0.0011	0.0002	0.0036
US	0.0000	0.0000	0.0002	0.0002	0.0001	0.0003
LIVPOOL						
BARGAINING CHANGE IN POLICY						
M_e	0.263	0.417	-1.185	-66.445	-5.813	-3.667
M_{us}	-1.447	-5.844	-3.327	122.215	19.098	3.054
PERCEIVED CHANGE IN TARGETS						
EUR. Y	0.352	0.042	-0.540	-4.123	-1.640	0.122
CA	0.015	0.080	-0.530	2.749	0.203	0.210
US Y	0.069	0.021	-0.557	-23.523	-1.848	-1.391
CA	0.107	0.464	0.339	-6.678	-1.233	-0.062
PERCEIVED GAIN FOR:						
EUR.	0.0006	0.0010	0.0215	1.7645	0.0258	0.0883
US	0.0131	0.0130	0.0890	6.4046	0.1943	0.0196
VAR						
BARGAINING CHANGE IN POLICY						
M_e	-2.039	-0.082	25.304	-16.346	-2.704	-11.157
M_{us}	-2.441	-0.349	-17.138	14.526	4.423	7.129
PERCEIVED CHANGE IN TARGETS						
EUR. Y	-0.337	-0.008	2.714	-2.180	-0.651	0.155
CA	0.004	-0.021	1.013	0.403	0.058	0.683
US Y	-2.442	-0.286	-5.262	5.991	2.506	1.999
CA	0.053	-0.006	-2.136	1.487	0.309	0.928
PERCEIVED GAIN FOR:						
EUR.	0.0030	0.0001	0.3256	0.0620	0.0035	0.0614
US	0.0362	0.0009	0.4349	0.3733	0.1023	0.0995
OECD						
BARGAINING CHANGE IN POLICY						
M_e	0.350	0.106	11.265	3.575	2.165	5.152
M_{us}	-0.733	-0.522	-6.305	1.050	1.854	3.338
PERCEIVED CHANGE IN TARGETS						
EUR. Y	0.265	0.011	1.341	0.952	0.337	0.531
CA	0.010	0.024	0.606	0.006	-0.001	-0.450
US Y	-0.297	-0.206	-2.240	1.037	0.796	1.424
CA	0.046	0.030	0.504	-0.069	-0.068	-0.098
PERCEIVED GAIN FOR:						
EUR.	0.0006	0.0001	0.1118	0.0079	0.0016	0.0288
US	0.0014	0.0004	0.0479	0.0128	0.0064	0.0222
LINK						
BARGAINING CHANGE IN POLICY						
M	0.370	0.162	24.517	5.006	3.465	7.124
M	-1.225	-1.448	-17.479	5.006	4.539	7.291
PERCEIVED CHANGE IN TARGETS						
EUR. Y	0.353	0.016	2.543	1.377	0.580	1.085
CA	0.014	0.034	0.879	0.043	0.011	-0.680
US Y	-0.297	-0.358	-3.757	1.377	1.221	2.001
CA	0.055	0.059	1.215	-0.077	-0.094	-0.116
PERCEIVED GAIN FOR:						
EUR.	0.0009	0.0003	0.3267	0.0161	0.0040	0.0594
US	0.0026	0.0006	0.1749	0.0240	0.0133	0.0529
MSG						
BARGAINING CHANGE IN POLICY						
M	-1.974	0.505	-0.374	-19.979	-3.804	73.035
M	-3.134	-7.884	-1.116	37.928	16.521	-177.978
PERCEIVED CHANGE IN TARGETS						
EUR. Y	-0.192	0.050	-0.177	-1.151	-1.174	-14.146
CA	0.010	0.094	-0.175	0.347	0.167	-1.768
US Y	-0.383	-0.553	-0.112	1.346	0.954	-7.871
CA	-0.204	-0.093	-0.047	-0.905	-0.017	2.652
PERCEIVED GAIN FOR:						
EUR.	0.0054	0.0013	0.0021	0.1876	0.0113	1.5561
US	0.0022	0.0033	0.0203	0.0731	0.0200	2.*462

* 99 INDICATES MORE THAN 20 STEPS REQUIRED FOR CONVERGENCE

Table 4: TRUE GAINS FROM COORDINATION FOR US

MODEL SUBSCRIBED TO BY THE UNITED STATES	MODEL SUBSCRIBED TO BY EUROPE					
	MCM	LIVPOOL	VAR	OECD	LINK	MSG
MCM						
MODEL REPRESENTING REALITY:						
MCM	0.0000	0.0000	0.0002	0.0002	0.0001	0.0003
LIVPOOL	-0.0163	0.0000	0.4107	-0.3202	-0.1723	0.0210
VAR	-0.0016	0.0000	0.1054	-0.3223	-0.1829	-0.0365
OECD	0.0047	0.0000	0.0259	-0.0003	-0.0024	0.0080
LINK	0.0033	0.0000	0.0371	0.0109	0.0039	0.0242
MSG	0.0003	0.0000	0.1625	-0.0133	-0.0107	0.0945
LIVPOOL						
MODEL REPRESENTING REALITY:						
MCM	-0.3143	-1.2444	-1.1065	32.7613	5.3305	0.8029
LIVPOOL	0.0131	0.0130	0.0890	6.4046	0.1943	0.0196
VAR	-1.1283	-4.7473	-4.0474	79.9530	16.0235	1.7168
OECD	-0.3607	-1.4373	-1.3234	36.9301	6.1384	0.8823
LINK	-0.1442	-0.5787	-0.5431	14.9634	2.4761	0.3381
MSG	-0.0197	-0.1205	-0.0866	0.7284	0.1479	-0.0951
VAR						
MODEL REPRESENTING REALITY:						
MCM	-0.1035	-0.0009	1.0198	0.6432	0.2438	-0.0936
LIVPOOL	0.3850	0.0217	6.5806	1.2352	0.0465	-0.9447
VAR	0.0362	0.0009	0.4349	0.5733	0.1023	0.0995
OECD	-0.0896	0.0051	1.7074	0.3395	0.1769	-0.3319
LINK	-0.0545	0.0010	1.0815	0.0651	0.0646	-0.2494
MSG	-0.0451	-0.0083	1.8950	0.0595	0.0172	-0.4154
OECD						
MODEL REPRESENTING REALITY:						
MCM	-0.0148	-0.0085	-0.1282	0.0393	0.0326	0.0360
LIVPOOL	0.0277	0.0337	2.1314	-0.9580	-0.6158	-0.1307
VAR	0.0403	-0.0294	-0.4089	-0.9364	-0.6461	0.0597
OECD	0.0014	0.0004	0.0479	0.0128	0.0064	0.0222
LINK	0.0018	0.0009	0.1632	0.0336	0.0194	0.0607
MSG	-0.0007	-0.0034	0.7470	-0.0389	-0.0287	0.2566
LINK						
MODEL REPRESENTING REALITY:						
MCM	-0.0208	-0.0239	-0.6656	0.0435	0.0426	0.0304
LIVPOOL	0.0673	0.0912	4.2232	-1.4711	-1.1872	-0.4153
VAR	0.0938	-0.0827	-2.3338	-1.7866	-1.5426	-0.1349
OECD	0.0047	-0.0004	-0.3033	-0.0429	-0.0426	-0.0507
LINK	0.0026	0.0006	0.1749	0.0240	0.0133	0.0529
MSG	-0.0025	-0.0149	1.4232	-0.0591	-0.0573	0.3809
MSG						
MODEL REPRESENTING REALITY:						
MCM	0.0650	2.0999	-0.8294	-0.7457	0.2652	56.0664
LIVPOOL	0.6330	1.1778	0.1315	-1.0070	-1.0438	40.7234
VAR	1.1802	8.1539	-2.6465	-7.4367	-2.4378	287.8572
OECD	0.1458	2.7800	-1.0058	-1.9362	-0.0983	122.0806
LINK	0.0389	1.1210	-0.4077	-0.8513	-0.0287	50.7028
MSG	0.0022	0.0033	0.0203	0.0731	0.0200	2.4462

Table 5: TRUE GAINS FROM COORDINATION FOR EUROPE

MODEL SUBSCRIBED TO BY THE UNITED STATES	MODEL SUBSCRIBED TO BY EUROPE					
	MCM	LIVPOOL	VAR	OECD	LINK	MSG
MCM						
MODEL REPRESENTING REALITY:						
MCM	0.0001	0.0000	0.5814	-0.0495	-0.0324	0.2317
LIVPOOL	-0.1420	0.0000	1.5990	-1.3006	-0.6650	0.0902
VAR	-0.0362	0.0000	0.0068	-0.9144	-0.4806	-0.5601
OECD	0.0008	0.0000	0.1575	0.0011	-0.0031	0.1024
LINK	0.0034	0.0000	0.1865	0.0080	0.0002	0.1022
MSG	-0.0148	0.0000	0.1294	-0.1425	-0.0737	0.0036
LIVPOOL						
MODEL REPRESENTING REALITY:						
MCM	0.0006	0.0490	-0.0673	24.6930	1.8955	0.3986
LIVPOOL	-0.0163	0.0010	0.9510	65.6996	3.3405	1.3406
VAR	-0.0215	-0.1833	0.0215	-9.5028	-0.5859	-0.0860
OECD	-0.0328	-0.1735	-0.1327	1.7645	0.3410	-0.0722
LINK	0.0125	0.0331	-0.0050	1.8552	0.0258	-0.0595
MSG	-0.0463	-0.2105	-0.0540	5.3524	0.5910	0.0883
VAR						
MODEL REPRESENTING REALITY:						
MCM	0.0030	0.0100	11.1868	1.1389	0.3014	-2.1764
LIVPOOL	1.0570	0.0001	25.8508	12.6236	2.1972	-1.6444
VAR	1.4471	0.1032	0.3256	0.7633	-0.6664	0.7496
OECD	-0.0738	-0.0105	1.7854	0.0620	0.0341	-0.4019
LINK	-0.0365	-0.0021	2.9089	-0.0572	0.0035	-0.6781
MSG	0.0929	-0.0051	1.4449	1.1609	0.1869	0.0614
OECD						
MODEL REPRESENTING REALITY:						
MCM	0.0006	0.0388	3.2829	-0.1469	-0.0803	0.3904
LIVPOOL	-0.1967	0.0001	7.5258	-3.3736	-1.9818	-0.0362
VAR	0.1543	0.0943	0.1118	-2.8419	-1.8731	-1.8926
OECD	-0.0040	-0.0062	0.7044	0.0079	0.0021	0.2904
LINK	0.0062	0.0077	0.9989	0.0090	0.0016	0.2266
MSG	-0.0198	-0.0093	0.4740	-0.3708	-0.2241	0.0238
LINK						
MODEL REPRESENTING REALITY:						
MCM	0.0009	0.0931	6.6253	-0.1366	-0.0855	0.3928
LIVPOOL	-0.2075	0.0003	13.7141	-4.3933	-3.2407	-0.1515
VAR	0.3236	0.2896	0.3267	-4.6755	-3.8416	-3.4599
OECD	-0.0089	-0.0232	1.3168	0.0161	0.0041	0.4447
LINK	0.0067	0.0151	2.0340	0.0152	0.0040	0.2959
MSG	-0.0201	-0.0255	0.7206	-0.5136	-0.3940	0.0594
MSG						
MODEL REPRESENTING REALITY:						
MCM	0.0054	1.0414	-0.1139	0.1488	0.5251	84.5778
LIVPOOL	1.3657	0.0013	1.0894	13.7576	3.0086	61.9314
VAR	2.3199	4.4082	0.0021	-8.1086	-5.6647	75.3953
OECD	-0.0320	-0.0063	-0.0091	0.1876	0.1157	3.4265
LINK	-0.0244	0.0960	0.0229	-0.2326	0.0113	11.9152
MSG	0.1798	0.0765	0.0561	1.2095	0.1542	1.5561

For each combination we report first whether the Nash equilibrium is stable, and the number of moves needed to reach convergence starting from the baseline.[12] We then report the values of the two countries' variables of interest in the equilibrium: the money supply (relative to the baseline), the perceived output and current account (relative to baseline, first, and then relative to the optimum) and the perceived welfare function (relative to the baseline). It usually turns out that both countries think they can do better than the baseline even without cooperating, but not always. All but two of the 36 cases call for expansion by one country or the other.

Our main interest lies in the move from the non-cooperative to the bargaining equilibrium, shown in Table 3. To take one example, if the U.S. policy-maker believes in the MCM model and the European policy-maker believes in the OECD model, then they can agree to expand further their money supplies simultaneously (0.36 percent and 1.59 percent, respectively). They each believe that this policy package will result in higher output with little adverse effect on their current accounts. This is the often-mentioned case in which the Nash equilibrium is too contractionary. But besides the case of simultaneous expansion (9 combinations of models), every other case is possible, as well: European expansion with U.S. contraction (12 combinations), U.S. expansion with European contraction (8 combinations), and simultaneous contraction (5 cases).

Without knowing the true model, we can not determine whether any given policy package actually improves welfare. But we can get a good idea of the possibilities by trying out each of the models as a candidate for the true model. The 36 cells in Tables 4 and 5 correspond to the same 36 combinations as Tables 2 and 3. But within each cell we report the effect that the corresponding coordination package of Table 3 would have under each of the 6 models; thus there are $6^3 = 216$ combinations altogether.[13] Table 4 shows the actual effect of coordination on U.S. welfare and Table 5 the effect on European welfare. Whenever one or the other policy-makers turns out to have had the right model, his country does gain from coordination. Otherwise he would not have agreed to the package. For example the joint monetary expansion that they agree on when the U.S. policy-maker believes the MCM model and the European policy-maker believes the OECD model is seen to raise U.S. welfare if the MCM model is the true one (Table 4) and to raise European welfare if the OECD model is the true one (Table 5). It also turns out to raise both countries' welfare if the LINK model is the true one. But it turns out to reduce welfare if the LIVPL, VAR or MSG model is the correct one. The reader who does not believe in one of the latter three models might not be concerned with that result. But such a reader should instead be concerned with the result that when the U.S. policy-maker, for example, believes in the LIVPL model and the European policy-maker in the VAR model, coordination will reduce welfare according to each of the other models.[14]

Altogether there are $8^3 = 512$ combinations (counting those with the EEC and MINIMOD models in addition to those shown in the tables). Coordination turns out to result in gains for the United

States in 289 cases, as against losses in 206 cases and no perceptible effect (to four decimal places) in 17 cases. For Europe there are gains in 297 cases, as against losses in 198 cases and no effect in 17 cases. These figures in a sense overstate the odds in favor of successful coordination, in that by construction each country's welfare is improved (or at least not worsened) in 1/8 of the combinations, those in which the policy-maker has the same model as the true one. If we exclude such combinations and take only the 8 x 7 x 6 = 336 combinations where all three models are different, the margin is narrower. For the United States there are gains in 168 cases, as against losses in 156 cases and no effect in 12. For Europe there are gains in 170 cases, losses in 154 and no effect in 12.

The results thus suggest that the danger that coordination will worsen welfare rather than improve it is more than just a pathological counterexample. It is true, but beside the point, that the proper strategy, if the correct model could be discovered, would be simply for both policy-makers to optimize subject to it. The point is that one cannot, under conditions where policy-makers do subscribe to different models, make the blanket pronouncement that coordination must improve welfare.

Section 3: International Coordination of Monetary and Fiscal Policy Together

In this section we give each country a second tool, government expenditure - g for the United States and g^* for Europe. We must add a third target variable for each country; otherwise each will be able to attain its optimal point regardless what the other country does. We choose the inflation rate. Now 24 multipliers are relevant from each model: the effects of m, m^*, g and g^* on U.S. output, current account and inflation and European output, current account and inflation.

Table 6 reports the 24 multipliers for each of the eight models. There is not as much disagreement regarding fiscal policy as monetary policy. A domestic fiscal expansion in most of the models is transmitted positively to the other country, via a domestic current account deficit. But a few models have fiscal or monetary expansion reducing the domestic price level rather than raising it.

We again assume that each country seeks to minimize a quadratic loss function. Rather than repeating our earlier points in algebraic form, we turn directly to the simulation results. As before, the weights and target optimums are taken from Oudiz and Sachs (1984). The inflation target is zero for both the United States and Europe. Thus policy-makers will seek to reduce inflation, as well as increase output and the current account.

Table 7 reports the Nash non-cooperative equilibrium for the six models.[15] The movement from the baseline to the Nash involves fiscal expansion as often as contraction. (Both fiscal authorities contract in 9 case, both expand in 9, and only one expands in 18.) But the money supply is expanded more often (both central banks contract in 8 cases, both expand in 18 cases, and one expands in 10.)

Table 8 reports the Nash bargaining solution. To take one example, when the United States subscribes to the LINK model and Europe

Table 6a: Fiscal Policy

Simulation Effect in Second Year of Increase in Government Expenditure (1 Percent of GNP)

	Y	CPI	i (pts.)	Currency Value	CA ($b)	CA* ($b)	i* (pts.)	CPI*	Y*
Fiscal Expansion in U.S. (-Sim. B)	Effect in U.S.					Effect in Non-U.S.			
MCM	+1.8%	+0.4%	+1.7	+2.8%	-16.5	+8.9	+0.4	+0.4%	+0.7%
EEC 1/	+1.2%	+0.6%	+1.5	+0.6%	-11.6	+6.6	+0.3	+0.2%	+0.3%
EPA 2/	+1.7%	+0.9%	+2.2	+1.9%	-20.5	+9.3	+0.5	+0.3%	+0.9%
LINK	+1.2%	+0.5%	+0.2	-0.1%	-6.4	+1.9	NA	-0.0%	+0.1%
Liverpool	+0.6%	+0.2%	+0.4	+1.0%	-7.0	+3.4	+0.1	+0.6%	-0.0%
MSG	+0.9%	-0.1%	+0.9	+3.2%	-21.6	+22.7	+1.0	+0.5%	+0.3%
MINIMOD	+1.0%	+0.3%	+1.1	+1.0%	-8.5	+5.5	+0.2	+0.1%	+0.3%
VAR 3/	+0.4%	-0.9%	+0.1	+1.2%	-0.5	-0.2	-0.0	-0.0%	-0.0%
OECD	+1.1%	+0.6%	+1.7	+0.4%	-14.2	+11.4	+0.7	+0.3%	+0.4%
Taylor 3/	+0.6%	+0.5%	+0.3	+4.0%	NA	NA	+0.2	+0.4%	+0.4%
Wharton	+1.47	+0.3%	+1.1	-2.1%	-15.4	+5.3	+0.6	-0.1%	+0.2%
DRI	+2.1%	+0.4%	+1.6	+3.2%	-22.0	+0.8	+0.4	+0.3%	+0.7%
Fiscal Expansion in Non-U.S. OECD (Sim. G)	Effect in Non-U.S.					Effect in U.S.			
MCM	+1.4%	+0.3%	+0.6	+0.3%	-7.2	+7.9	+0.5	+0.2%	+0.5%
EEC 1/	+1.3%	+0.8%	+0.4	-0.6%	-9.3	+3.0	+0.0	+0.1%	+0.2%
EPA 2/	+2.3%	+0.7%	+0.3	-0.7%	-13.1	+4.7	+0.6	+0.3%	+0.3%
Link	+1.2%	+0.1%	NA	-0.1%	-6.1	+6.3	+0.0	+0.0%	+0.2%
Liverpool	+0.3%	+0.8%	+0.0	+3.3%	-17.2	+11.9	+0.8	+3.1%	-0.5%
MSG	+1.1%	+0.1%	+1.4	+2.9%	-5.3	+10.5	+1.3	+0.6%	+0.4%
MINIMOD	+1.6%	+0.2%	+0.9	+0.6%	-2.2	+3.2	+0.3	+0.2%	+0.1%
VAR 3/	+0.5%	-0.3%	-0.2	-2.4%	+1.7	-2.6	+0.2	-0.1%	+0.3%
OECD	+1.5%	+0.7%	+1.9	+0.9%	-6.9	+3.3	+0.3	+0.2%	+0.1%
Taylor 3/	+1.6%	+1.2%	+0.6	+2.7%	NA	NA	+0.4	+0.9%	+0.6%
Wharton	+3.2%	-0.8%	+0.8	-2.4%	-5.5	+4.7	+0.1	-0.0%	+0.0%
DRI	NA	NA	NA	NA	NA	NA	NA	NA	NA

1/ Non-U.S. short-term interest rate NA; long-term reported instead.

2/ Non-U.S. current account is Japan, Germany, the United Kingdom, and Canada.

3/ CPI NA. GNP deflator reported instead.

Table 6. Money and Fiscal Multipliers

(For three targets in each country)

	Percentage Effect on Income		Effect on Current Account (As Percentage of GNP):		Effect on Percentage Inflation Rate	
From a (1 percent) increase in:	U.S. m	Eur. m	U.S. m	Eur. m	U.S. m	Eur. m
Effect on U.S.						
MCM	0.3750	0.0000	-0.0198	0.0006	0.1000	-0.0500
Liverpool	0.0250	0.4000	-0.0832	-0.0525	0.9250	-0.8500
VAR	0.7500	0.3000	0.0311	-0.0634	0.1000	-0.1750
OECD	0.4000	0.0250	-0.0537	0.0147	0.1750	-0.0250
LINK	0.2500	0.0250	-0.0380	0.0225	-0.1000	0.0000
MSG	0.0750	0.0750	0.0167	0.0769	0.3750	-0.1500
EEC	0.2500	0.0250	-0.0180	0.0122	0.2000	0.0250
MINIMOD	0.2500	-0.0750	0.0179	-0.0089	0.2000	-0.1250
Effect on "Europe"						
MCM	-0.1750	0.3750	-0.0090	0.0090	-0.1500	0.1500
Liverpool	0.0000	0.1000	0.0034	0.2384	0.0000	0.7000
VAR	0.1000	0.1750	0.1169	0.1192	0.0250	-0.1250
OECD	0.0750	0.2000	0.0178	-0.0091	-0.0250	0.0750
LINK	-0.0250	0.2000	0.0083	-0.0077	-0.0250	-0.1500
MSG	0.1000	0.0500	-0.0206	-0.0743	-0.1750	0.3750
EEC	0.0500	0.2000	0.0159	-0.0689	-0.1000	0.2500
MINIMOD	-0.0500	0.2000	-0.0226	-0.0173	-0.0500	0.0500
From an increase (equal to 1% of GNP):	U.S. g	Eur. g	U.S. g	Eur. g	U.S. g	Eur. g
Effect on U.S.						
MCM	1.8000	0.5000	-0.4217	0.2019	0.4000	0.2000
Liverpool	0.6000	-0.5000	-0.1791	0.3045	0.2000	3.1000
VAR	0.4000	0.3000	-0.0127	-0.0659	-0.9000	-0.1000
OECD	1.1000	0.1000	-0.3628	0.0843	0.6000	0.2000
LINK	1.2000	0.2000	-0.1647	-0.1621	0.5000	0.0000
MSG	0.9000	0.4000	-0.5540	0.2693	-0.1000	0.6000
EEC	1.2000	0.2000	-0.2990	0.0773	0.6000	0.1000
MINIMOD	1.0000	0.1000	-0.2172	0.0818	0.3000	0.2000
Effect on "Europe"						
MCM	0.7000	1.4000	0.0912	-0.0737	0.4000	0.3000
Liverpool	-0.0000	0.3000	0.4566	-2.3097	0.6000	0.8000
VAR	-0.0000	0.5000	-0.0183	0.1559	0.0000	-0.3000
OECD	0.4000	1.5000	0.2583	-0.1564	0.3000	0.7000
LINK	0.1000	1.2000	0.0420	-0.1349	0.0000	0.1000
MSG	0.3000	1.1000	0.4246	-0.0991	0.5000	0.1000
EEC	0.3000	1.3000	0.3499	-0.4931	0.2000	0.8000
MINIMOD	0.3000	1.6000	0.1058	-0.0423	0.1000	0.2000

Table 7: Nash Non-cooperative Equilibrium (Monetary and Fiscal Policies)

MODEL SUBSCRIBED TO BY THE UNITED STATES	MODEL SUBSCRIBED TO BY EUROPE					
	MCM	LIVPOOL	VAR	OECD	LINK	MSG
MCM						
NASH POINT: STABLE?	YES	YES	YES	YES	YES	YES
STEPS	99	2	99	99	3	99
DEVIATION OF NASH FROM BASELINE						
M_e	84.121	-2.379	-21.461	162.955	21.613	289.611
M_{us}	61.919	11.514	-72.894	121.011	1.033	451.319
G_e	-4.641	0.179	16.644	-11.799	3.983	-72.760
G_{us}	-10.454	-4.258	7.988	-18.054	-2.346	-65.202
PERCEIVED DEVIATION OF TARGET FROM BASELINE						
EUR. Y	6.894	-0.164	-2.723	17.498	9.048	-39.394
CA	-0.412	-1.845	-8.670	-1.687	-0.708	-50.453
P	-2.244	-2.709	-4.133	-3.916	-2.870	-9.270
US Y	2.081	-3.256	-4.635	6.982	-1.843	15.502
CA	2.299	1.602	1.422	2.939	1.787	4.051
P	-3.124	-0.397	0.308	-5.628	-1.119	-9.981
PERCEIVED DEVIATION OF TARGET FROM GOAL						
EUR. Y	-3.806	-10.884	-13.423	6.798	-1.652	-50.094
CA	-2.025	-0.059	-0.619	-2.606	-1.179	-51.494
P	0.556	0.091	-1.333	-1.116	-0.070	-6.470
US Y	-2.889	-8.225	-9.605	2.012	-6.813	10.532
CA	-0.377	-1.074	-1.254	0.263	-0.889	1.375
P	1.476	4.203	4.908	-1.028	3.481	-5.381
PERCEIVED GAIN FOR:						
EUR.	2.3065	1.9517	9.1459	1.2092	2.5290	-384.0674
US	1.9633	0.2180	-0.5052	2.0896	0.8432	-1.0544
LIVPOOL						
NASH POINT: STABLE?	YES	YES	YES	YES	YES	YES
STEPS	99	99	99	99	6	99
DEVIATION OF NASH FROM BASELINE						
M_e	25.561	7.073	-14.985	-85.702	21.804	26.344
M_{us}	4.000	6.280	-72.656	-64.883	2.894	18.921
G_e	5.179	-0.783	14.017	-8.528	4.388	1.401
G_{us}	-14.407	-11.732	31.945	42.645	-13.085	-21.966
PERCEIVED DEVIATION OF TARGET FROM BASELINE						
EUR. Y	4.454	0.472	-2.879	-17.903	8.225	-1.934
CA	-1.710	-1.842	-8.677	11.883	-1.296	-11.946
P	-1.887	-2.714	-4.148	1.897	-2.904	-4.432
US Y	-0.909	-3.662	4.348	-3.051	-1.251	-2.869
CA	2.424	0.970	5.375	-0.344	2.296	1.406
P	-4.853	-4.976	-4.627	-5.080	-4.271	-4.941
PERCEIVED DEVIATION OF TARGET FROM GOAL						
EUR. Y	-6.246	-10.228	-13.579	-28.603	-2.475	-12.634
CA	-3.322	-0.055	-0.626	10.964	-1.737	-12.987
P	0.913	0.086	-1.348	4.697	-0.104	-1.632
US Y	-5.879	-8.632	-0.622	-11.021	-6.221	-7.039
CA	-3.233	-4.747	-0.342	-6.061	-3.421	-4.311
P	-0.256	-0.376	-0.027	-0.480	-0.271	-0.341
PERCEIVED GAIN FOR:						
EUR.	1.0314	2.0906	9.0942	-25.7920	2.2628	-21.7531
US	2.8693	1.6342	3.9092	0.2255	2.7436	2.0313
VAR						
NASH POINT: STABLE?	YES	YES	YES	YES	YES	YES
STEPS	10	3	4	99	3	3
DEVIATION OF NASH FROM BASELINE						
M_e	-91.284	-12.492	-228.102	-77.290	22.046	-17.041
M_{us}	21.711	7.424	31.877	24.682	-2.232	5.979
G_e	21.248	1.197	105.304	-0.836	3.820	9.986
G_{us}	22.978	8.170	41.477	23.063	0.006	7.906
PERCEIVED DEVIATION OF TARGET FROM BASELINE						
EUR. Y	6.418	-0.890	15.922	-5.677	9.059	13.099
CA	-0.665	-1.849	-7.811	7.197	-0.700	3.506
P	-2.174	-2.703	-2.291	-0.111	-2.869	-2.490
US Y	4.464	5.447	3.659	4.296	6.088	5.530
CA	4.758	0.840	7.980	5.428	-1.718	0.507
P	-4.659	-4.544	-4.754	-4.679	-4.429	-4.534
PERCEIVED DEVIATION OF TARGET FROM GOAL						
EUR. Y	-4.282	-11.590	5.222	-16.377	-1.641	2.399
CA	-2.278	-0.063	0.241	6.278	-1.172	2.466
P	0.626	0.097	0.519	2.689	-0.069	0.310
US Y	-0.506	0.477	-1.311	-0.672	1.118	0.560
CA	2.022	-1.906	5.235	2.682	-4.464	-2.238
P	-0.059	0.056	-0.154	-0.079	0.131	0.066
PERCEIVED GAIN FOR:						
EUR.	2.1062	1.7928	11.0198	-6.5560	2.5316	1.9699
US	1.9568	1.9878	0.3766	1.7463	0.8832	1.8944

(cont.)

Table 7 (cont.)

MODEL SUBSCRIBED TO BY THE UNITED STATES	MCM	LIVPOOL	VAR	OECD	LINK	MSG
	MODEL SUBSCRIBED TO BY EUROPE					
OECD						
NASH POINT: STABLE?	YES	YES	YES	YES	YES	YES
STEPS	4	4	99	10	3	3
DEVIATION OF NASH FROM BASELINE						
M_e	70.151	13.439	-125.280	242.431	17.156	33.738
M_{us}	38.830	52.001	-25.836	38.736	37.542	47.443
G_e	-2.054	-1.374	60.947	-26.119	6.076	-1.703
G_{us}	-13.552	-18.782	-10.220	-5.411	-15.801	-16.941
PERCEIVED DEVIATION OF TARGET FROM BASELINE						
EUR. Y	5.837	0.932	5.966	10.048	8.223	-0.497
CA	-0.974	-1.839	-8.270	1.169	-1.297	-10.470
P	-2.089	-2.718	-3.270	-2.693	-2.904	-4.246
US Y	2.173	0.339	-18.613	12.991	-1.328	1.016
CA	3.691	4.106	8.392	1.244	4.483	3.953
P	-3.501	-2.780	4.668	-7.752	-2.125	-3.046
PERCEIVED DEVIATION OF TARGET FROM GOAL						
EUR. Y	-4.863	-9.768	-4.734	-0.652	-2.477	-11.197
CA	-2.587	-0.053	-0.213	0.250	-1.739	-11.510
P	0.711	0.082	-0.470	0.107	-0.104	-1.446
US Y	-2.797	-4.631	-23.233	8.021	-6.298	-3.954
CA	0.633	1.047	5.334	-1.814	1.425	0.894
P	1.099	1.820	9.263	-3.152	2.475	1.554
PERCEIVED GAIN FOR:						
EUR.	1.8299	2.1826	11.0793	2.8106	2.2620	-16.4753
US	2.1661	1.8358	-11.1282	0.7959	1.3941	1.9767
LINK						
NASH POINT: STABLE?	YES	YES	YES	YES	YES	YES
STEPS	1	1	2	2	1	1
DEVIATION OF NASH FROM BASELINE						
M_e	15.625	-0.607	-218.097	259.271	18.504	7.151
M_{us}	24.752	25.187	19.722	26.012	24.793	24.881
G_e	6.036	0.016	100.706	-28.713	5.196	4.470
G_{us}	-4.172	-4.038	-5.538	-3.912	-4.162	-4.131
PERCEIVED DEVIATION OF TARGET FROM BASELINE						
EUR. Y	5.608	-0.056	14.158	9.093	8.900	6.492
CA	-1.096	-1.845	-7.892	1.535	-0.814	-3.285
P	-2.056	-2.710	-2.457	-2.536	-2.876	-3.344
US Y	2.779	1.439	12.974	2.548	2.706	2.336
CA	1.078	-0.302	11.579	0.840	1.003	0.622
P	-4.561	-4.538	-4.741	-4.557	-4.560	-4.564
PERCEIVED DEVIATION OF TARGET FROM GOAL						
EUR. Y	-5.092	-10.756	3.458	-1.607	-1.800	-4.208
CA	-2.709	-0.058	0.159	0.616	-1.285	-4.326
P	0.744	0.090	0.343	0.264	-0.076	-0.544
US Y	-2.191	-3.531	8.004	-2.422	-2.264	-2.634
CA	-2.257	-3.637	8.244	-2.495	-2.332	-2.713
P	0.039	0.062	-0.141	0.043	0.040	0.046
PERCEIVED GAIN FOR:						
EUR.	1.7114	1.9795	11.2074	2.7352	2.4888	0.1267
US	2.0846	1.4619	-2.7279	1.9980	2.0584	1.9110
MSG						
NASH POINT: STABLE?	YES	YES	YES	YES	YES	YES
STEPS	99	2	99	99	2	7
DEVIATION OF NASH FROM BASELINE						
M_e	-340.937	-2.383	-38.936	106.250	22.878	-35.344
M_{us}	-250.455	-13.214	-65.938	52.193	-8.425	-53.195
G_e	63.777	0.151	24.059	-13.529	3.519	16.957
G_{us}	-13.097	-2.250	0.359	2.725	0.360	-0.952
PERCEIVED DEVIATION OF TARGET FROM BASELINE						
EUR. Y	-5.278	-0.193	-1.378	5.925	9.056	11.280
CA	-6.887	-1.846	-8.608	2.749	-0.702	1.637
P	-0.464	-2.709	-3.999	-2.016	-2.869	-2.725
US Y	-30.631	-3.134	2.081	8.924	2.816	-0.714
CA	-5.977	0.884	2.185	3.892	2.368	1.487
P	-3.204	-4.282	-4.487	-4.755	-4.516	-4.377
PERCEIVED DEVIATION OF TARGET FROM GOAL						
EUR. Y	-15.978	-10.893	-12.078	-4.775	-1.644	0.580
CA	-8.500	-0.059	-0.557	1.830	-1.174	0.537
P	2.336	0.091	-1.199	0.784	-0.369	0.075
US Y	-35.601	-8.104	-2.889	3.354	-2.134	-5.624
CA	-8.883	-2.022	-0.721	0.987	-0.538	-1.418
P	1.336	0.318	0.113	-0.155	0.084	0.223
PERCEIVED GAIN FOR:						
EUR.	-10.2147	1.9498	9.5663	2.0280	2.5309	2.8053
US	-13.8102	1.3565	2.1756	2.0714	2.2284	1.8332

* 99 INDICATES MORE THAN 20 STEPS REQUIRED FOR CONVERGENCE

Table 8: Bargaining Solution

(Movement from Non-cooperative to Cooperative Solution)

MODEL SUBSCRIBED TO BY THE UNITED STATES	MODEL SUBSCRIBED TO BY EUROPE: MCM	LIVPOOL	VAR	OECD	LINK	MSG
MCM						
BARGAINING CHANGE IN POLICY						
M_e	78.269	2.769	5.891	-42.735	3.897	-193.811
M_{us}	53.240	15.606	4.048	-30.387	-12.622	-313.885
G_e	-10.246	-0.423	-0.389	-0.494	-0.953	52.659
G_{us}	-6.339	-3.516	-2.432	4.696	2.544	43.894
PERCEIVED CHANGE IN TARGETS						
EUR. Y	1.253	0.150	1.241	-9.687	0.208	30.014
CA	0.402	0.085	1.160	1.144	0.101	34.282
P	-1.855	-0.507	-0.519	-1.382	-0.365	9.467
US Y	3.432	-0.687	-3.055	-3.189	-0.631	-12.369
CA	-0.400	1.090	0.871	-1.506	-1.013	-1.784
P	-3.174	-0.069	-0.941	0.878	-0.630	6.391
PERCEIVED GAIN FOR:						
EUR.	0.0001	0.0002	0.0001	0.0001	0.0002	341.6131
US	0.0007	0.0000	0.0001	0.0001	0.0001	3.1469
LIVPOOL						
BARGAINING CHANGE IN POLICY						
M_e	6.059	0.207	5.185	102.122	3.916	-67.414
M_{us}	5.179	0.123	4.956	61.935	-6.416	-67.269
G_e	0.313	0.011	0.194	13.043	2.099	-1.343
G_{us}	-2.103	-0.424	-3.573	-53.046	8.217	41.768
PERCEIVED CHANGE IN TARGETS						
EUR. Y	0.333	0.024	1.479	23.417	4.286	0.956
CA	-0.207	-0.169	1.293	-15.580	-0.022	24.263
P	-0.615	-0.100	-0.552	-0.673	-0.218	7.243
US Y	1.136	-0.173	-0.048	4.051	5.289	-2.913
CA	-0.277	0.058	0.015	2.965	-0.505	1.240
P	0.188	-0.114	0.027	0.303	-1.118	-0.735
PERCEIVED GAIN FOR:						
EUR.	0.0001	0.0001	0.0084	22.2700	0.0003	0.0002
US	0.0001	0.0000	0.0013	2.5648	0.0001	0.0000
VAR						
BARGAINING CHANGE IN POLICY						
M_e	1.994	-0.018	42.442	34.760	-0.616	0.891
M_{us}	1.252	-0.099	-19.127	-4.290	2.437	0.347
G_e	-1.096	-0.023	-14.905	5.993	-1.027	-4.083
G_{us}	-0.010	-0.104	-6.986	-10.330	1.285	-0.704
PERCEIVED CHANGE IN TARGETS						
EUR. Y	-1.013	-0.008	-1.933	11.490	-1.286	-4.623
CA	0.087	0.003	0.627	-3.956	0.217	0.032
P	-0.222	-0.088	-1.311	3.811	-0.073	-0.484
US Y	1.205	-0.126	-8.879	4.378	1.852	-0.976
CA	-0.015	0.000	-2.213	-2.601	0.165	0.232
P	-0.105	0.088	-1.561	2.184	-0.704	0.919
PERCEIVED GAIN FOR:						
EUR.	0.0003	0.0001	0.0002	0.0003	0.0001	0.0040
US	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000

MODEL SUBSCRIBED TO BY THE UNITED STATES	MODEL SUBSCRIBED TO BY EUROPE: MCM	LIVPOOL	VAR	OECD	LINK	MSG
OECD						
BARGAINING CHANGE IN POLICY						
M_e	53.059	2.961	2.650	-3.971	9.024	-19.90[illegible]
M_{us}	28.292	11.818	4.347	-1.649	-29.990	-9.21[illegible]
G_e	-9.291	-0.456	-1.794	0.730	-2.672	-9.66[illegible]
G_{us}	-5.795	-3.655	-0.547	-1.297	9.101	4.217
PERCEIVED CHANGE IN TARGETS						
EUR. Y	-2.117	0.166	0.001	-0.340	0.260	-11.28[illegible]
CA	0.379	0.132	0.554	-0.442	0.424	4.41[illegible]
P	-1.390	-0.480	0.316	-0.134	-0.872	-4.70[illegible]
US Y	5.340	0.735	1.024	-2.113	-2.026	-0.51[illegible]
CA	0.581	0.697	-0.147	0.562	-1.786	-2.14[illegible]
P	-1.711	-0.290	0.008	-0.822	-0.548	-0.51[illegible]
PERCEIVED GAIN FOR:						
EUR.	0.0002	0.0013	0.0310	0.0002	0.0002	0.000[illegible]
US	0.0001	0.0000	0.5669	0.0001	0.0001	0.000[illegible]
LINK						
BARGAINING CHANGE IN POLICY						
M_e	4.860	0.175	183.151	94.647	0.838	-8.86[illegible]
M_{us}	18.015	2.235	-82.610	-6.347	10.105	-5.84[illegible]
G_e	2.107	0.043	-79.515	-10.613	0.563	2.21[illegible]
G_{us}	0.210	-0.195	-5.502	-2.513	0.877	0.90[illegible]
PERCEIVED CHANGE IN TARGETS						
EUR. Y	1.770	0.030	-15.967	1.229	0.679	1.67[illegible]
CA	-0.254	-0.139	-0.121	0.072	0.038	0.94[illegible]
P	-1.256	0.041	-1.104	-1.066	-0.222	-1.62[illegible]
US Y	1.245	-0.164	-19.992	-2.971	1.438	1.15[illegible]
CA	-0.267	-0.042	-4.724	1.033	-0.418	0.23[illegible]
P	-1.697	-0.321	5.510	-0.622	-0.572	1.03[illegible]
PERCEIVED GAIN FOR:						
EUR.	0.0001	0.0002	2.3575	0.0001	0.0002	0.000[illegible]
US	0.0001	0.0001	9.3584	0.0000	0.0001	0.0001
MSG						
BARGAINING CHANGE IN POLICY						
M_e	493.547	0.993	6.596	-8.970	1.302	-0.61[illegible]
M_{us}	326.238	1.080	2.660	-4.905	1.453	-0.24[illegible]
G_e	-98.052	0.033	-1.269	0.197	0.090	0.61[illegible]
G_{us}	-6.648	-0.990	0.074	-2.756	0.595	-0.67[illegible]
PERCEIVED CHANGE IN TARGETS						
EUR. Y	-13.935	0.110	0.787	-2.968	0.393	0.4[illegible]
CA	8.124	-0.285	0.899	-0.748	0.015	-0.2[illegible]
P	-6.977	0.134	-0.378	-1.239	-0.224	-0.46[illegible]
US Y	16.280	-0.722	0.254	-3.442	0.778	-0.4[illegible]
CA	20.691	0.652	0.169	0.808	-0.180	0.46[illegible]
P	-9.861	0.373	-0.762	-0.101	0.343	0.43[illegible]
PERCEIVED GAIN FOR:						
EUR.	0.0004	0.0002	0.0001	0.0000	0.0002	[illegible]
US	0.0001	0.0001	0.0000	0.0001	0.0000	[illegible]

* 99 INDICATES MORE THAN 20 STEPS REQUIRED FOR CONVERGENCE

Table 9: TRUE GAINS FROM COORDINATION FOR US

MODEL SUBSCRIBED TO BY THE UNITED STATES	MODEL SUBSCRIBED TO BY EUROPE					
	MCM	LIVPOOL	VAR	OECD	LINK	MSG
MCM						
MODEL REPRESENTING REALITY:						
MCM	0.0007	0.0000	0.0001	0.0001	0.0001	3.1469
LIVPOOL	-417.0703	-32.5580	3.7415	89.0365	-22.5915	667.9237
VAR	-106.6272	-7.7687	5.9412	74.6168	-1.1505	1514.1071
OECD	-7.7722	-0.1183	-0.1502	5.6047	0.2561	137.1037
LINK	-14.3229	-0.3971	4.0174	10.6110	-1.8597	404.2240
MSG	-17.7636	-9.7439	2.4105	26.1071	0.8274	657.6596
LIVPOOL						
MODEL REPRESENTING REALITY:						
MCM	-1.9039	-0.5021	6.2772	54.4563	7.3414	9.8998
LIVPOOL	0.0001	0.0000	0.0013	2.5648	0.0001	0.0000
VAR	-3.0797	-0.7547	14.5411	73.8011	9.8608	5.8246
OECD	-0.4930	-0.2207	3.9436	42.6516	2.6546	-1.6866
LINK	-1.8294	-0.2444	11.2962	95.0969	2.8645	-16.6592
MSG	-4.0967	-0.3162	10.1331	105.3657	6.1541	-4.7476
VAR						
MODEL REPRESENTING REALITY:						
MCM	0.5074	0.1400	133.9095	30.5077	-0.1103	1.9968
LIVPOOL	95.1089	0.6575	7325.9709	210.1759	-0.7166	93.4674
VAR	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000
OECD	-0.2307	0.1881	111.6205	32.4433	-0.7517	2.0946
LINK	0.1694	0.0716	16.7006	14.8435	-0.3587	0.3201
MSG	2.3140	0.1051	318.0400	29.4297	-0.1739	4.1346
OECD						
MODEL REPRESENTING REALITY:						
MCM	-3.9503	-2.0147	1.0032	-0.9966	3.1369	0.7415
LIVPOOL	-306.3305	-32.7059	154.8106	141.2328	115.2568	-0.0185
VAR	-36.5966	-20.3116	0.5767	10.8611	26.6199	8.6341
OECD	0.0001	0.0000	-0.5669	0.0001	0.0001	0.0001
LINK	-10.1591	-7.0590	0.2836	-0.3550	6.4676	3.0614
MSG	-7.0943	-18.4216	-1.6533	1.4717	35.1396	18.3815
LINK						
MODEL REPRESENTING REALITY:						
MCM	-3.1205	-0.0692	332.3664	-23.5513	-1.8124	-0.6074
LIVPOOL	-134.1558	-8.5029	40702.9221	-5210.2928	-54.8456	-55.2357
VAR	-9.4738	-0.8703	160.2344	-113.1868	-4.3254	1.8500
OECD	-7.2673	-0.3444	214.7298	-5.1188	-4.4792	-0.1211
LINK	0.0001	0.0001	9.3584	0.0000	0.0001	0.0001
MSG	-21.7539	-1.7152	1051.1986	-154.0192	-9.6820	-0.8625
MSG						
MODEL REPRESENTING REALITY:						
MCM	100.3656	-0.3982	0.5411	2.0741	0.1030	-0.5552
LIVPOOL	3207.6754	0.0414	50.6519	42.6355	0.7561	-12.1393
VAR	863.2930	-0.4783	4.1806	13.2235	-0.0595	-0.8929
OECD	209.6478	-0.0625	0.7413	5.4953	-0.2240	-0.5277
LINK	28.6763	0.2415	0.4119	0.2273	-0.1055	0.3096
MSG	0.0001	0.0001	0.0000	0.0001	0.0000	0.0001

Table 10: TRUE GAINS FROM COORDINATION FOR EUROPE

MODEL SUBSCRIBED TO BY THE UNITED STATES	MODEL SUBSCRIBED TO BY EUROPE					
	MCM	LIVPOOL	VAR	OECD	LINK	MSG
MCM						
MODEL REPRESENTING REALITY:						
MCM	0.0001	-5.7115	6.2052	-0.5567	-10.0076	1046.2591
LIVPOOL	-1789.9261	0.0002	3.9337	1033.6325	-31.6800	7487.1062
VAR	-139.4767	-5.7958	0.0001	104.1679	3.0774	846.5881
OECD	-0.9016	0.2703	4.2436	0.0001	-1.8627	631.8359
LINK	-106.4474	0.6730	3.5786	63.3150	0.0002	680.4074
MSG	-208.7456	-5.7529	0.1807	126.3151	-25.2457	341.6131
LIVPOOL						
MODEL REPRESENTING REALITY:						
MCM	0.0001	-0.3040	15.2290	35.9664	-6.7729	-12.7178
LIVPOOL	-23.5538	0.0001	-19.8038	315.2757	-69.1329	-20.6131
VAR	-5.5930	-0.0922	0.0084	58.4799	-0.5042	11.1753
OECD	-0.6888	-0.1927	6.7803	22.2700	-7.6506	-5.3158
LINK	-0.5156	0.0171	2.5522	64.6068	0.0003	-21.9587
MSG	-4.7699	-0.5015	14.1976	79.1709	-14.5723	0.0002
VAR						
MODEL REPRESENTING REALITY:						
MCM	0.0003	0.0155	1.5533	10.1595	0.7828	2.0503
LIVPOOL	51.6531	0.0001	3039.1691	219.6790	4.2128	44.5563
VAR	-0.5486	0.0138	0.0002	24.0867	0.0444	-0.5179
OECD	4.5541	0.0853	276.3468	0.0003	1.4149	11.2411
LINK	3.1549	-0.0141	143.6578	25.8744	0.0001	1.0776
MSG	4.1138	0.0396	344.7457	74.2394	0.9535	0.0040
OECD						
MODEL REPRESENTING REALITY:						
MCM	0.0002	-18.5244	1.6689	6.5260	7.2392	-18.9440
LIVPOOL	-860.9982	0.0013	208.6597	275.0462	-29.5220	-42.0260
VAR	-64.0132	-7.6985	0.0310	7.2243	10.9674	13.4161
OECD	-2.0992	-4.0098	20.1705	0.0002	-0.9968	-19.1384
LINK	-52.5301	-0.4937	9.4823	10.4913	0.0002	-2.6157
MSG	-120.0077	-20.0802	-2.1904	55.8701	-0.9412	0.0000
LINK						
MODEL REPRESENTING REALITY:						
MCM	0.0001	-0.6087	99.4058	-141.9204	0.2656	0.2545
LIVPOOL	-49.2724	0.0002	21068.9488	-5458.4715	-13.3575	-10.3326
VAR	-12.3365	-0.8205	2.3575	-171.6856	-5.3763	4.1767
OECD	-3.0302	0.0724	1255.3096	0.0001	-1.2477	-3.0702
LINK	0.1189	0.0826	785.5309	-254.2982	0.0002	-1.7708
MSG	-0.5358	-0.6480	2701.6594	-1360.7969	1.5012	0.0001
MSG						
MODEL REPRESENTING REALITY:						
MCM	0.0004	0.2503	-1.2875	4.1266	-0.8120	0.4024
LIVPOOL	12112.2199	0.0002	77.9596	259.6382	-12.1070	-24.7898
VAR	352.0500	-0.2717	0.0001	11.9010	-0.9584	0.0812
OECD	76.4938	0.0599	3.5728	0.0000	-0.8154	-1.3583
LINK	761.0515	0.2519	5.9392	8.7298	0.0002	-0.8501
MSG	1080.8400	0.0860	-2.3298	47.4820	-2.8069	0.0003

to the LIVPL model, the resulting package of coordinated policy changes takes exactly the form urged by many economists in the 1980s: a U.S. fiscal contraction, accompanied by a fiscal expansion in the rest of the OECD and monetary expansion all around.[16] This package is considered desirable because it would depreciate the dollar and reduce the U.S. current account deficit (and European and Japanese surplus) without causing a large world recession.[17] But most other possible kinds of policy packages occur as well: U.S. fiscal contraction and monetary expansion accompanied by either European expansion (6 cases) or European fiscal contraction and monetary expansion (9 cases); general U.S. contraction accompanied in Europe by either general expansion (1 case), loose fiscal and tight money (3 cases), tight fiscal, loose money (3 cases) or general contraction (1); general U.S. expansion accompanied in Europe by either general expansion (3), monetary expansion and fiscal contraction (1), or general contraction (1); and, finally, U.S. fiscal expansion and monetary contraction accompanied in Europe by either general expansion (1), fiscal expansion and monetary contraction (2), fiscal contraction and monetary expansion (2), or general contraction (3).[18]

Tables 9 and 10 show the true gains from coordination for the U.S. and Europe, respectively. Again we find that coordination necessarily improves U.S. welfare if the U.S. model turns out to be the correct one, and European welfare if the European model turns out to be the correct one, but that otherwise welfare can go down. Of the total 512 combinations of all eight models, the United States has gains in 282 cases, losses in 228, and no perceptible effect in 2. Europe has gains in 283 cases, losses in 219, and no effect in 10. If we take only the 336 combinations where the U.S. model, European model and true model are all different, bargaining results in U.S. gains in 183 cases and losses in 153, and for Europe gains in 166 cases and losses in 170. Thus the odds for successful coordination appear to be no better when policy-makers can take advantage of the monetary-fiscal mix than when the degree of monetary ease is alone at stake.

Section 4: Extensions

This paper has made the simplest assumptions to examine the topic at hand. But many extensions suggest themselves. Most have to do with the introduction of uncertainty, which would seem to come hand-in-hand with the consideration of disagreement regarding the true model. We here briefly discuss four such possible extensions.

To begin with, even if we retain our assumption that each policy-maker believes in his own model with certainty, he may be uncertain as to the model in which the other policy-maker believes. In the present paper it was assumed that each observes directly the other's policy settings, money supplies or government expenditures, so that each has no need to know the other's model. (Each could infer the other government's model from its policy actions, if it cared to.) But one could assume instead that the policy-maker does not observe the foreign governments policies continuously (think of the central bank's M1 target, as opposed to current M1) and that when it is making its decision, it must guess what the other might do based on (uncertain) guesses as to the other's model. Then the policy-maker will set its policies so as to maximize expected welfare, a weighted average of the economic consequences of each of the policy-settings that the foreign government would choose under each of the possible models in which it might believe. The foreign government's policy settings in turn will depend, not just on its model, but also on its beliefs about what the first country's model, and therefore its actions, might be. So the ordinary Nash equilibrium involves an extra degree of simultaneity.

The U.S. central bank chooses m to minimize

$$\sum_{i=1}^{8} \pi_i^* W_i(m_i, m_i^*)$$

where π_i^* is the U.S. estimate of the probability that Europe believes in model i and m_i^* is the money supply Europe will pick if it believes in model i. If the U.S. central bank believes in, for example, model 1, then the first order condition is similar to equation (7), but with the foreign money supply replaced by a weighted average of the possibilities:

$$(7') \qquad m_1 = M_1 + N_1 \sum_{i=1}^{8} \pi_i^* m_i^*$$

or

$$m_1 = M_1 + N_1(\underline{\pi^{*\prime} m^*})$$

where $\underline{\pi^{*\prime}}$ is the row vector of π_i^* and $\underline{m^*}$ is the column vector of m_i^* (each for i=1,8, assuming eight possible models).

Similarly the European central bank chooses m^* to minimize

$$\sum_{i=1}^{8} \pi_i W_i^*(m_i, m^*),$$

where π_i is the European estimate of the probability that the United States believes in model i, and m_i is the money supply the United States will pick if it believes in model i. If the European central bank believes in, for example, model 2, then the first order condition is

$$(8') \qquad m_2^* = Q_2 + R_2(\underline{\pi'm})$$

where $\underline{\pi'}$ is the row vector of π_i and $\underline{m}$ is the column vector of m_i. We have one version of equation (7') for each of the eight models in which the U.S. central bank might believe, giving

$$(7'') \qquad \underline{m} = \underline{M} + \underline{N}(\underline{\pi^{*\prime}m^*})$$

and similarly for Europe,

$$(8'') \qquad \underline{m^*} = \underline{Q} + \underline{R}(\underline{\pi'm})$$

where $\underline{M}$, $\underline{N}$, $\underline{Q}$ and $\underline{R}$ are the vector forms of M_1, N_1, Q_1 and R_1, respectively. Substituting and solving,

$$(12) \qquad \underline{m} = [\underline{I} - \underline{N\pi^{*\prime}R\pi'}]^{-1} [\underline{M} + \underline{N\pi^{*\prime}Q}] \quad .$$

$$(13) \qquad \underline{m^*} = [\underline{I} - \underline{R\pi'N\pi^{*\prime}}]^{-1} [\underline{Q} + \underline{R\pi'M}] \quad .$$

where $\underline{I}$ is the identity matrix.

Equations (12)-(13) represent the 8x8 computable Nash non-cooperative solutions for the 8x8 combinations of models in which the two policy-makers could believe. As a concrete example we could try putting equal weight on each of our eight Brookings models: $\pi_i = \pi_i^* = 1/8$ (i=1,8). The bargaining solution remains the same as before, assuming that each policy-maker reveals his model as part of the cooperative bargain. As before we could calculate in each case the gain or loss in welfare entailed in the move from one equilibrium to the other, where the true effect of any given pair of money supplies is judged by each of the eight models in turn.

The second extension would view policy-makers as not so stubborn as to believe in their own models with certainty. Now they assign some probability to the possibility that each of the eight models may be true, and choose their policies so as to maximize expected welfare, as in Brainard (1967).[19] In a simple version we could go back to assuming that each knows the views of the other policy-maker (now a set of probabilities). We could even assume that each modifies in a Bayesian manner his own beliefs when he learns the beliefs of the other player. However if each is so reasonable as to base his beliefs solely on the statistical estimator that optimally combines the data available to him with that available to the other player, then each will come to the same conclusion. To get disagreement about the model -- and it is the premise of this line of research that such disagreement is an accurate description and crucial characteristic of the actual policy-making environment -- it is necessary that the policy-makers have either incomplete access to each other's data or (what can be thought of as much the same thing) different Bayesian priors.

The third extension would be to assume both uncertainty about the true model (as in the second extension) and uncertainty about what probabilities the other policy-maker assigns to the models (as in the first extension). Here it would be possible to assume that the policy-makers originally shared the same priors, but that they have observed different sets of data and have come to different conclusions for that reason. Let Z_1 be the set of data from which U.S. economists obtained the maximum likelihood point estimates of the parameters that we have been calling model 1. Such estimates come with standard errors that imply (in terms of classical statistics) the probabilities that one could have observed Z_1 conditional on each of the other models in fact being true, or (in terms of Bayesian statistics) the probabilities that each of the models could in fact be true conditional on the known fact that Z_1 has been observed. Similarly if Z_2 is the set of data from which European economists obtained a maximum likelihood estimate that we have been calling model 2, then Bayesian methods will give us (conditional on Z_2 and a set of priors, which may be the same as the U.S. set of priors) European probabilities that each of the models is true. Then each policy-maker will choose his money supply so as to maximize expected welfare, taking into account all the different data sets that the other central bank could have drawn and the money supplies that it would consequently set, and also taking into account the different possible true models and the consequent effects on the macroeconomy. The interesting application of Bayesian principles comes in the realization that the two kinds of uncertainty are not independent. The probability that a given action by the foreign central bank will have the consequences implied by model 2 is greater if that action is the one that would be optimally chosen based on the observation of the data set Z_2, i.e., that data set that would imply model 2 as the maximum likelihood estimate.

These three extensions are more elaborate models of the Nash non-cooperative equilibrium, but none offers an evident reason for altering our conclusion that the bargaining solution is as likely to reduce welfare as to improve it. For those interested in making coordination work, it is natural to ask whether there might not be some other cooperative solution concept (that is, mapping from the players' beliefs and welfare functions to their policy settings) that would turn out to improve welfare by light of the true model more often than does the Nash bargaining equilibrium in Tables 4 and 5.

Under certain conditions, the weighted average of two statistical estimators will be a better estimator of a parameter than either considered alone. If the policy-makers' models are treated as different statistical estimators of the true model, it might be better to channel the bargaining process to focus on parameters rather than directly on policy settings, and then to set policy so as to maximize joint welfare under the compromise model. It is not obvious what is the relevant stage at which to "average to get the best parameter estimate." Do we want the best estimates of the structural parameters such as the elasticities of money demand? The best estimates of functions of those such as the reduced form money multipliers C and D? Functions of those like the reaction parameter N? These alternatives are not equivalent because the functions are nonlinear. If, following the Nash bargaining solution, the goal is to maximize the product of the countries' expected welfare gains relative to the Nash noncooperative equilibrium, then the first-order conditions turn out to be stated in terms of expected products of multipliers such as E(CH), the expectation (based on available data) of the product of the multiplier of U.S. money on U.S. income and the multiplier of European money on U.S. income. If we were willing to think of each model's estimate of CH as being equal to the true CH plus an independent random error (which could be either of equal or different variances across models), then the best estimate of CH conditional on any two available models 1 and 2 would be a weighted average of their estimates $\theta(CH)_1 + (1-\theta)(CH)_2$ (with either equal or unequal weights, as appropriate). The coordinating agent would then calculate the value of m and m^* that satisfied the first order conditions in terms of these averaged multiplier-products, and would instruct the two central banks to adopt those monetary policies, assuming they wish to avoid a breakdown to the Nash non-cooperative equilibrium. The extension of the present line of research would be to calculate the effects of such compromises by using, again, each of the eight models as possible true models, and to see if the result is an improvement in the countries' welfare levels any more often than when the conventional Nash bargaining solution is used. If so, the prescriptive implication would be that policy-makers in OECD or G-7 meetings might better spend their time debating directly their views of the world, rather than debating only over the policies that they would like each other to adopt.

It is not a matter of deciding whether the treatment in the present paper is adequate. Extensions such as those sketched in this section need to be pursued. It is only a matter of sorting out which extensions are highest priority, a process in which we trust some of our readers will assist.

FOOTNOTES

1 Hamada (1976) is generally credited with the birth of the topic in its modern analytic form (though under the assumption of fixed exchange rates). More recent contributions include Canzoneri and Gray (1983). Miller and Salmon (1985), Rogoff (1985) and Buiter and Marston (1985). For good introductions to the literature and further references, see Oudiz and Sachs (1984) or Cooper (1985).

2 There are two important qualifications to the generality of the proposition that coordination improves welfare under the standard assumption that policy-makers know the true model. The first is that if policy-makers have enough independent instruments to reach their optimum target goals regardless of each others' actions, then coordination is moot. The second is that Rogoff (1985) and Kehoe (1986) have shown that if coordination reduces governments' ability to precommit to anti-inflationary policies, credibly to their own peoples, then it can reduce welfare. The present paper is a counterexample along very different lines.

3 Oudiz and Sachs (1984) and Ishii, McKibbin and Sachs (1985).

4 The project was entitled "Empirical Macroeconomics for Interdependent Economic." Frankel (1986a) discusses the disagreements among the 12 models.

5 Indeed many of the authors in the coordination literature decline to take any position at all on whether the problem with the Nash non-cooperative equilibrium is that it is too contractionary or too expansionary, etc. They leave it for econometricians to fill in the correct parameter values at some later date.

6 One's intuition is that players who disagree about the model will find it harder to agree on a package of joint policy changes. The correct way to interpret this intuition is probably that, even if there exists a bargaining solution that is believed Pareto-superior to the non-cooperative solution, it will be harder for the players to agree on a mechanism to enforce the bargaining solution if they do not share a common view of the world. In an interesting account that he believes may carry lessons for macroeconomic coordination, Cooper (1986) describes the history of international cooperation in the sphere of public health; cooperation was first proposed early in the 19th century, but because there were conflicting schools of thought on whether diseases were carried internationally by travelers, actual cooperation did not take place until a consensus was achieved around 1900 as to the correct model of the transmission of disease. If there are positive costs to an enforcement mechanism and some parties believe the gains from coordination are small, then it will not take place.

7 This holds in the eight econometric models considered in the following section except the LIVPL and MSG models.

8 More often, it has been private economists, and the governments of smaller countries, who have urged such coordinated expansion; e.g.,

Bergsten, et al (1982). The 1981-84 Reagan Administration opposed coordination.

9 In equations (3) and (4), one could simply redefine m* as fiscal policy, and let $y^* \equiv y$, $x^* \equiv x$, and $\omega^* \equiv \omega$. As long as the two policy-makers have different parameter estimates, there will still be scope for coordination. The only difference is that in Figure 2 the true optimal points P and O would coincide.

10 The positive effect of a monetary expansion on the current account via currency depreciation is offset by a negative effect via higher income. In the Mundell-Fleming model the positive effect on the current account must dominate, to match the net capital outflow that results from lower interest rates, giving negative transmission abroad. But in more modern models the net capital flow may be reversed, in response to perceived overshooting of the exchange rate. The theoretical literature contains many other ways of reversing the Mundell-Fleming transmission results as well. (See Mussa (1979) or, for an optimizing approach, Svensson and van Wijnbergen (1986)). On the models used in the Brookings simulations, see Frankel (1986a), or other papers in Bryant and Henderson.

11 The alternative weights tried were: first, equal weight on both targets and, second, a weight of 20 times greater on the current account than on GNP (for both countries). Different targets tried were: a GNP target 95% of the baseline level for the US, and a GNP target of 95% of the baseline level for Europe. For these experiments, the magnitude of the changes in targets and instruments was the same as in the example presented. The total count for true gains and losses for the two countries were:

Relative weight ω (income/current account)	Cases of: U.S. gains	European gains
1/1	154	156
1/20	168	178
Target changed to:		
$\bar{y}$ = 95% of baseline	169	163
$\bar{y}$ = 55% of baseline	180	163

12 There is only one case of technical instability, the combination of the MSG and VAR models. In this case the U.S. reaction function is steeper than the European reaction function because the transmission effects are strong relative to the own multiplier effects.

13 The diagonal entries of the three-dimensional matrix are the cases where both policy-makers have the correct model. The calculations correspond conceptually to those in Oudiz and Sachs (1984) for the MCM and EPA models.

14 The most bizarre combination occurs when the U.S. believes the LIVPL model and Europe believes the OECD model. Under this combination, the Nash non-cooperative equilibrium entails a mutually destructive increase in the European money supply of almost 100 percent and decrease in the U.S. money supply of over 100 percent (!) (Evidently the problem is that the Liverpool model shows European monetary expansion raising U.S. output much more than does U.S. monetary expansion, as can be seen in Table 1.)

15 All combinations show technical stability, but convergence is slow in several cases.

16 Examples include Blanchard and Dornbusch (1984), Layard et al (1984) and Marris (1985).

17 Table 8 shows that according to the MSG model this change in the monetary/fiscal mix, though increasing non-U.S. output 0.1 percent and having the desired effect on the current accounts, would in fact reduce U.S. output 0.7 percent. There are several other combinations in the table where this same change in mix results from coordination, all of them involving the LIVPL model; but none of them shows quite the expected effects on the target variables.

18 As in the case of coordination of monetary policy alone, there are a few cases of absurdly large changes, in particular the two combinations with the MSG and MCM models. The explanation, again, is that these changes offset absurdly large changes implied by the move from the baseline to the Nash equilibrium in Table 7.

19 Brainard assumed a continuous probability distribution for the parameters (rather than assigning discrete probabilities to 12 models, as suggested here). Roubini (1986) applies this assumption to international coordination.

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