UC Berkeley
Other Recent Work

Title

The Sources of Disagreement Among International Macro Models, and Implications for Policy Coordination

Permalink

https://escholarship.org/uc/item/2fd768nz

Author

Frankel, Jeffrey A.

Publication Date

1987-01-26

Peer reviewed

eScholarship.org Powered by the California Digital Library
University of California

UNIVERSITY OF CALIFORNIA, BERKELEY

Department of Economics

Berkeley, California 94720

Working Paper 8725

THE SOURCES OF DISAGREEMENT AMONG INTERNATIONAL MACRO MODELS, AND IMPLICATIONS FOR POLICY COORDINATION

Jeffrey A. Frankel

January 26, 1987

Key words: Models, coordination, monetary and fiscal policy.

JEL Classification: 300, 430

ABSTRACT

This study makes use of the simulation results of 12 leading large international econometric models, as to the effects of commonly specified changes in monetary and fiscal policy, conducted under the Brookings exercise "Empirical Macroeconomics for Interdependent Economies." The first half of the paper examines disagreement among the models on the signs of policy multipliers, and how such disagreement compares to the ambiguities appearing in the theoretical literature. There turns out to be relatively little disagreement as to the effects on output, prices and the exchange rate. The greatest disagreement is rather over the question whether a monetary expansion worsens or improves the current account.

The second half of the study examines the implications for international macroeconomic policy coordination. The existing literature makes the unrealistic assumption that policy-makers all know the true model, from which it follows that the Nash bargaining solution is in general superior to the Nash competitive solution. But everything changes once we recognize that policy-makers' models, as the models in the Brookings simulations, differ from each other and therefore from the "true" model. When the central bank and fiscal authorities subscribe to conflicting models, it is still true that (1) the competitive equilibrium is sub-optimal, and that (2) the two authorities will in general be able to agree on a cooperative policy package that each believes will improve the objective function; however, (3) 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. Out of 1,210 possible combinations of different models subscribed to by the two policy authorities and models representing reality, bargaining raises welfare in only 819 cases. The conclusion is that disagreement as to the true model may be a more serious obstacle to successful policy coordination than is institutional failure to enforce Pareto-improving solutions.

Ambiguous Macroeconomic Policy Multipliers in Theory and in Twelve Econometric Models

Revised October 6, 1986

Jeffrey A. Frankel
Department of Economics
University of California
Berkeley, CA 94720

On Leave: Oct.-Dec. 1986
Research Department, 9-518
International Monetary Fund
Washington, D.C. 20431

ABSTRACT

This paper makes use of the simulation results of 12 leading large international econometric models, as to the effects of commonly specified changes in monetary and fiscal policy, conducted under the Brookings exercise "Empirical Macroeconomics for Interdependent Economies." It examines disagreement among the models on the signs of policy multipliers, and how such disagreement compares to the ambiguities appearing in the theoretical literature. There turns out to be relatively little disagreement as to the effects on output, prices and the exchange rate. The greatest disagreement is rather over the question whether a monetary expansion worsens or improves the current account and accordingly whether it is transmitted positively or negatively to the rest of the world.

Forthcoming, Empirical Macroeconomics for Interdependent Economies, edited by Ralph Bryant and Dale Henderson (Brookings Institution: Washington, D.C.)

Ambiguous Macroeconomic Policy Multipliers, in Theory and in Twelve Econometric Models*

It is perhaps for the eye of the beholder to judge whether twelve large econometric models, as simulated in the Brookings Institution project on Empirical Macroeconomics for Interdependent Economies, are surprisingly similar or surprisingly dissimilar in their estimates of the effects of macroeconomic policy changes. But this paper takes the mischievous tack of examining disagreement where it is at its greatest: where the models give answers of opposite sign. We will consider the reduced-form policy multipliers of both monetary policy and fiscal policy. Our discussion of how the multipliers are determined will include (a) the divergent multipliers one would expect to get from the standard theoretical models that appear in the literature, (b) the divergent multipliers that emerge from the simulations in the Brookings modelling simulation exercise, (c) an attempt to interpret (b) in terms of (a).

---

*This paper is the first of three on the implications of conflicting international models for macroeconomic policy coordination. Part two, which appears in this volume, considers the implications of the conflicts found here for coordination between a country's monetary and fiscal authorities. (Parts one and two appear also in NBER Working Paper 1925.) Part three, co-authored with Katharine Rockett, considers the implications for coordination between countries. The author would like to acknowledge useful discussion with Ralph Bryant, Rudiger Dornbusch, John Helliwell, Dale Henderson, Bert Hickman, Gerry Holtham, Patrick Minford, and Warren Trepeta, and to thank the Institute of Business and Economic Research at U.C. Berkeley, for typing. Views expressed are the author's.

We examine the models' conflicting implications for the effects of a change in government expenditure, and the effects of a change in the money supply, in each case with the other policy variables (domestic and foreign) held constant. The most well-known ambiguity is the question of whether a fiscal expansion causes the domestic currency to appreciate or depreciate. The other ambiguity that appears most commonly in the theoretical literature is the effect of the exchange rate, and therefore the effect of domestic policy, on foreign income. The issue of whether transmission is positive or negative is of course crucial to questions of international policy coordination. Somewhat surprisingly, neither of these issues is the one on which the simulations in the Brookings exercise show the most conflict. Most of the models show a fiscal expansion appreciating the domestic currency and raising foreign output. The models are in much greater disagreement on an issue that much of the literature considers unambiguous: the negative effect of a domestic monetary expansion on the foreign current account and, via the trade linkage, on foreign output.

We begin by considering the standard theoretical two-country model.

1. The Standard Two-Country Model

Since the model is so familiar, we circumscribe the algebra tightly. Though we specify the equations in relatively general form, we then proceed to consider only special cases.

(1) $M/P = L(Y, i)$ $\qquad \phi \equiv L_y > 0 \quad \lambda \equiv L_i < 0$

(2) $M^*/P^* = L^*(Y^*, i^*)$ $\qquad \phi^* \equiv L^*_{y*} > 0 \quad \lambda^* \equiv L^*_{i*} < 0$

(3) $Y = A(Y, i; SP^*/P) + G + TB$ $\qquad A_y > 0 \quad A_i < 0$

(4) $Y^* = A^*(Y^*, i^*; SP^*/P) + G^* - (SP^*/P)TB$ $\qquad A^*_{y*} > 0 \quad A^*_{i*} < 0$

(5) $TB = X(SP^*/P) + \mu^* Y^* - \mu Y$ $\qquad X_S > 0$

(6) $TB = -KA = -K(i-i^*; S/\bar{S})$ $\qquad k \equiv K_{i-i*} > 0$

(7) $Y/\bar{Y} = (P/\bar{P})^{\sigma}$

(8) $Y^*/\bar{Y}^* = (P^*/\bar{P}^*)^{\sigma^*}$

where M ≡ money supply

P ≡ price level (domestic goods, unless otherwise stated)

Y ≡ output

i ≡ interest rate

S ≡ exchange rate

G ≡ government expenditures

TB ≡ trade balance

Equations (1) and (2) give the money demand equations for the domestic and foreign countries, respectively. Equations (3) and (4) show the demands for goods. We allow for the possibility of a Laursen-Metzler effect, that a worsening of the terms of trade would raise expenditure measured in domestic units, by including the real exchange rate after the semi-colon. Equation (5) gives the trade balance. Equation (6) gives the capital outflow as a function of the nominal interest differential, and possibly of expected depreciation, where the latter is assumed to be a function of the spot rate relative to its equilibrium level. Under floating exchange rates the trade balance and capital outflow are equal. Finally, in equations (7) and (8) the supply of output is seen to be a function of the price level relative to an equilibrium value, which can be thought of as either the expected price level or as the cost of labor and other variable factors of production.

The above model leaves out many factors. Perhaps the most notable omissions are the stocks of government and international indebtedness.[1] Such omissions might be justified by an appeal to the short run, over which the stocks cannot change much:[2] our focus in the simulations will be on the effects in the second year after a policy change (just long enough for the trade balance to get past the negative part of the "J-curve"). In models with forward-looking expectations, of which the MSG, Liverpool, Minimod and Taylor models among the Brookings twelve are examples, long-run effects can be passed back through time to the short run. But even then, the effect is generally quantitative rather than qualitative. The sign of an effect is less likely to be

---

[1]Also omitted are some so-called "supply side" effects, such as the possibility that a balanced-budget reduction in tax rates and government expenditure would stimulate output and appreciate the currency. Such effects have been important in the thinking of the Reagan Administration and a few private economists, but they do not seem to be incorporated into any of the 12 models involved in the Brookings simulation exercise.

[2]See, for example, Henderson (1983) and the references cited there.

affected by the omission of such factors as stocks of indebtedness.[3]

We consider first the case when supply is infinitely elastic ($\sigma = \sigma^* = \infty$) so that the price levels P and P^* are fixed in the short run, and all variables that appear after the semi-colon are omitted. This is the standard Mundell-Fleming model.[4] Equation (6) for the trade balance can be substituted into equations (3) and (4); these two together with equations (1) and (2) determine four endogenous variables--Y, Y^*, i, and i^*--as a function of the four policy variables--G, M, G^*, and M^*. (Equation (5) then determines the exchange rate.)

A fiscal expansion in the Mundell-Fleming model has the following well-known effects. It increases domestic income Y and therefore the domestic interest rate i.[5] The differential between the domestic and foreign interest rates attracts a capital inflow which, ex post, corresponds to a trade deficit. If capital mobility is sufficiently high (if the slope of the Balance-of-payments equilibrium curve μ/k is less

---

[3]It is possible to get reversals of sign. For example, in some models a fiscal expansion could be contractionary if expectations of future debt drive up expected future short-term interest rates and current long-term interest rates, and therefore crowd out investment, enough. The Liverpool model appeared to show this effect for the case of a U.S. expansion in earlier work (Minford 1984, 100, 114, 133).

[4]Citations for the two-country Mundell-Fleming model are Mundell (1964), Mussa (1979), and Swoboda and Dornbusch (1973). Girton and Henderson (1976) was possibly the first two-country version of the portfolio-balance model, with the degree of substitutability between domestic and foreign bonds filling in for the Mundell-Fleming model's degree of capital mobility.

[5]In the limiting case of perfect capital mobility ($k = \infty$) and an exogenous foreign interest rate (small country), these effects vanish.

than the slope of the LM curve ϕ/λ), then the balance of payments would improve at an unchanged exhcange rate, which implies that the domestic currency appreciates under floating rates. The currency appreciation may be as important a cause of the trade deficit as is the increase in income. The counterpart foreign trade surplus increases foreign income Y^*. The primary ambiguity in the above story is whether capital mobility is high enough (or the LM curve steep enough) for the fiscal expansion to appreciate the currency; the reverse case appears as a prominent possibility in textbooks and in many of the large econometric models. Some of these models have been said to exhibit an asymmetry: fiscal expansion in the U.S. appreciates the currency but--whether because of lower capital mobility, a flatter LM curve, monetary accommodation, or other factors--fiscal expansion in Europe or Japan depreciates their currencies.

A monetary expansion has unambiguous effects in the Mundell-Fleming model. It reduces the domestic interest rate and therefore increases domestic income. The differential between domestic and foreign interest rates induces a capital outflow. The currency unambiguously depreciates, all the more if capital mobility is high. As a result the trade balance improves, notwithstanding the higher level of income; we know this because of the ex post net capital outflow. The stimulus to net foreign demand, i.e., the trade balance, may constitute a larger amount of the increase in output than the stimulus to domestic demand, i.e., investment and other interest-sensitive sectors. The corresponding worsening in the foreign trade balance reduces foreign income. Thus we get the classic Mundell-Fleming result of inverse transmission: a contractionary monetary policy such as the United States adopted in 1980-82 is expansionary for Europe, via the trade balance.

The theoretical literature features at least five ways that the foregoing transmission results can be reversed, via effects of the exchange rate on variables other than the trade balance.[6] The exchange rate S can enter the saving/expenditure decision via the terms of trade in equation (4), can enter money demand via the price level in equation (2), can enter expenditure via real wealth in equation (4), can enter supply via the price of imported inputs in equation (8), and can enter supply via the nominal wage rate, also in equation (8). We consider each briefly.

First, according to the Laursen-Metzler-Harberger effect, a worsening in the terms of trade, i.e., an increase in SP^*/P, should affect the saving/expenditure decision similarly to any other decline in real income. In the traditional Keynesian literature, this means a reduction in saving to protect living standards, as measured in domestic terms: $A_s > 0$.[7] The point of the original Laursen-Metzler (1950)

[6] There is also a way that the standard Mundell-Fleming result of negative transmission of monetary policy can be reversed via a reversal of the trade balance. It is if net capital inflows respond to expected future appreciation which, in turn, depends on the current level of the spot rate relative to its equilibrium level, as indicated in equation (6). Because discussion of this effect does not for the most part occur in the theoretical literature on international transmission, it is postponed to the following section.

[7] On the other hand, the modern theory of saving says that only if the currency depreciation is perceived as a temporary decline in real income or, in the case of a permanent decline, if the rate of time preference rises with a fall in welfare, will intertemporally-optimizing consumers react by reducing saving. See Obstfeld (1982) and Svensson and Razin (1983).

article was that, when a domestic expansion depreciates the domestic currency, the foreign country would respond to the improvement in its terms of trade by decreasing expenditure, giving the result of negative transmission under floating exchange rates. In the case of a monetary expansion, the Mundell-Fleming model's introduction of capital flows gave the negative transmission result anyway, so the Laursen-Metzler effect changes little. But in the case of a fiscal expansion (with low capital mobility, so that the domestic currency depreciates), this negative effect on foreign output could conceivably reverse the standard transmission result. This case seems less relevant under modern conditions of high capital mobility. For example, in the U.S. fiscal expansion of 1983-85, the dollar appreciated strongly. For the purposes of the following discussion of each of the remaining four effects, we assume for simplicity that a fiscal expansion appreciates the currency.

Though we have previously defined the price levels P and P^* to refer only to goods produced in the domestic and foreign countries, respectively, in the case of the money demand functions they could as easily be replaced by the consumer price indices, CPI and CPI*, defined as a Cobb-Douglas weighted average of own goods and imports:[8]

$$CPI = P^{\alpha}(SP^*)^{1-\alpha} \tag{9}$$

$$CPI^* = (P/S)^{\alpha^*}(P^*)^{1-\alpha^*} \tag{10}$$

A depreciation of the foreign currency ($S\downarrow$) will lower the real money

[8] See, for example, Branson and Buiter, 1983, 256-58.

stock M^*/CPI^*, exerting a contractionary effect on foreign output. If the fall in the exchange rate originated in a domestic fiscal expansion, this effect can reverse the standard Mundell-Fleming result of positive transmission to the foreign country. In the case of a domestic monetary expansion, the domestic currency depreciates, the foreign currency appreciates, CPI^* falls, the foreign real money stock rises and Y^* increases; transmission is positive. Thus both the positive transmission of fiscal policy and the negative transmission of monetary policy can be reversed. The effect on the real money stock was one of the lines of argument open to those Europeans who believed that the U.S. policy mix of the early eighties--tight money and a loose budget, resulting in a strong dollar--had adverse effects on European growth.

Similar to the negative effect of the exchange rate on the real money stock is the negative effect on the real stock of government bonds. A depreciation can be contractionary if real wealth enters the expenditure function. There is also a negative effect of the exchange rate on expenditure if the country in question is in debt to foreigners in foreign currency. Either of those effects is capable of reversing the effects on income through the trade balance, i.e., turning the positive transmission of fiscal policy into negative transmission and vice versa for monetary policy. (If a country is in debt in its own currency, as the United States is rapidly becoming, then a depreciation has a positive effect on wealth and expenditure, reinforcing the expansionary effects through the trade balance.)

Until now we have assumed, for the short run, infinitely elastic supply $(\sigma = \sigma^* = \infty)$ so that the output prices P and P^* are fixed (in their own currencies). Relaxing this assumption does not in itself change qualitative conclusions about movements in output, assuming the equilibrium price levels $\bar{P}$ and $\bar{P}^*$—whether interpreted as expected price levels or as markup functions of input costs—are constant in the short run. Where expansionary effects on Y were previously noted, they are replaced by increases in P and, as a result, smaller increases in Y. To be precise, only $\sigma/1+\sigma$ of an increase in aggregate demand will be reflected in higher output. All contractionary effects are similarly reduced. In a well-specified model, the changes in P should in the long run be large enough to eliminate any effects on Y. But we are concentrating on the short run, in which most models show increases in both P and Y.[9]

The last two ways that the standard transmission results can be reversed operate via the equilibrium price levels in the supply relationships. Assume that $\bar{P}$ and $\bar{P}^*$ in the supply functions are determined as markups over input costs; i.e., their rate of change is a linear function of the rate of change of the prices of oil and other inputs, the rate of change of wages, and the long-run rate of productivity

---

[9]Of course, there exist models in which prices rise so quickly that there is no effect on output even in the short run. At the opposite extreme, a few of the large econometric models represented in the Brookings simulations, have the property that an expansion actually <u>reduces</u> prices in the short run. This may come as a consequence of highly procyclical productivity and the (more questionable) assumption that prices are determined as a markup over current unit labor costs. Alternatively, in the case of a monetary expansion, prices may fall if capital costs (interest rates) are reflected in mark-up pricing: Hickman (1986, 33) identifies such an effect in the LINK and Wharton models for the United States, and it appears dominant in the LINK simulation results for France, Italy and Canada.

growth. An increase in input prices will shift the supply relationship adversely, reducing output. Thus, to the extent that the price of oil is determined in dollars, an appreciation of the dollar is contractionary for other countries. This effect of the exchange rate, like the effects on real money balances and real wealth, runs in the reverse direction from the standard trade balance effect in the Mundell-Fleming model: fiscal expansions that appreciate the currency can be transmitted negatively and monetary expansion transmitted positively, rather than the other way around. Thus, this route too was open to those who wished to argue that the strong dollar of the early 1980s hurt Europe.

The final variable that might depend on the exchange rate is the wage rate. (For simplicity, let $\bar{P}$ equal the wage rate.) If wages are fixed, or determined by the unemployment rate, then the standard results are not affected. On the other hand, if wages are fully indexed to the domestic price level, then equations (7) and (8) become $Y = \bar{Y}$ and $Y^* = \bar{Y}^*$: policy can have no effect on output in either country. The interesting case is when wages are indexed to the consumer price index, including import prices as in equations (9) and (10), because the exchange rate can open a gap between the CPI and P. Equations (7) and (8) then become

$$Y/\bar{Y} = (P/SP^*)^{(1-\alpha)\sigma} \tag{11}$$

$$Y^*/\bar{Y}^* = (P^*S/P)^{(1-\alpha^*)\sigma^*} . \tag{12}$$

It is clear that one country's output can go up only if the other country's output goes down. In the case of a domestic fiscal expansion that appreciates the currency (reduces S), there is a contractionary effect on foreign income that is similar to those we saw for the effects via real money, real wealth, and oil prices; all four work to reverse the Mundell-Fleming result of positive transmission. One might expect that a domestic monetary expansion, because it increases S in equation (12), would have the opposite effect from a fiscal expansion, that it would increase foreign income. But from equation (11) the monetary expansion would then have to reduce domestic income; this perverse result can be ruled out by the recognition from equation (3) that Y cannot fall unless i rises and reduces A or the currency appreciates and reduces TB, neither of which will follow from a monetary expansion. The only possible solution is that P rises by the same proportion as S (the increase in the money supply) and there are no real effects, either on domestic <u>or</u> foreign income.[10]

Table 1 summarizes the various possible transmission effects of the exchange rate. We now turn to the various results that appear in the Brookings simulations of large econometric models.

---

[10]Sachs (1980, 737) and Argy and Salop (1977, 2-12; 1979, 228). However if real wages are rigid in Europe and nominal wages are rigid in the United States, U.S. monetary policy <u>can</u> be transmitted positively. Argy and Salop (1977, 6-10), Oudiz and Sachs (1984, 13-14).

TABLE 1

THEORETICAL TRANSMISSION EFFECTS

	Fiscal Expansion with Low Capital Mobility	Fiscal Expansion with High Capital Mobility	Monetary Expansion
DOMESTIC CURRENCY:	Depreciates	Appreciates	Depreciates
EFFECTS ON FOREIGN OUTPUT:			
Effects via Trade Balance = Capital Outflow			
Interest Differential	Positive	Positive	Negative
Regressive Exchange Rate Expectations	Positive	Negative	Positive
Effects via Domestic Demand			
Laursen-Metzler Effect	Negative	Positive	Negative
Real Money Stock	Positive	Negative	Positive
Real Wealth	Positive	Negative	Positive
Effects via Supply			
Imported Inputs	Positive	Negative	Positive
Wage Indexation	Positive	Negative	Positive

2. Fiscal Policy Multipliers in the Simulations

Table 2 summarizes the effects of a fiscal expansion, an increase in government spending equal to one percent of GNP, according to the 12 models in the Brookings simulations. (The U.S. expansion is represented by Simulation B with all signs reversed. The non-U.S. OECD expansion is Simulation G.) The variables shown are output, the consumer price index, the short-term interest rate, the exchange rate, and the current account. The left columns show the variables in the region originating the fiscal expansion, and the right columns the foreign region. For simplicity the table shows the effects only in the second year relative to the baseline.

The most well-known theoretical ambiguity, the effect on the exchange rate, turns out to generate relatively little disagreement. In the case of a U.S. fiscal expansion, ten models show an appreciation of the dollar. The only exceptions are the LINK and Wharton models, which report a depreciation, evidently attributable to little or no capital mobility. In the case of a non-U.S. fiscal expansion, there is more divergence. But six out of eleven models still show the standard high capital mobility result, a domestic appreciation against the dollar. The exceptions now include also the EEC, EPA, and VAR models. The asymmetry between the exchange rate effects of U.S. fiscal expansion and European or Japanese expansion, which here shows up only in these three models, has been attributed to a variety of possible reasons. One of them, a greater tendency to monetize government deficits abroad than in the United States, should have been ruled out by the careful specification in the Brookings experiment that money supplies are held constant.

Table 2. 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. C)	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.

Another reason suggested, lower capital mobility (k), could explain econometric findings for individual non-U.S. countries but cannot explain the asymmetry in a well-specified two-country Mundell-Fleming model: capital mobility into the United States cannot be higher than capital mobility out of the rest of the world. The same applies to the argument that non-U.S. countries are more open to trade than the United States; given that the non-U.S. economy is larger than the U.S., it must be less open in the aggregate. One explanation that works is a steeper LM curve in the United States so that U.S. interest rates are more easily driven up.[11]

For either U.S. or non-U.S. fiscal policy the simulations show that changes are transmitted positively to the rest of the world, in all the structural models but one. This is not surprising. Including even the few cases where a fiscal expansion depreciates the currency, the domestic current account is observed to worsen in all the structural models (as it must in standard theory; it is the worsening of the trade balance, if it is big enough, that is the cause of any downward pressure on the currency under Mundell-Fleming). The foreign current account and

[11] Oudiz and Sachs (1984, 7, 9, 22) find the asymmetry present in the MCM and EPA models, and attribute it to the slopes of the LM curve and the importance of dollar assets in the world portfolio. Yoshitomi (1984, 34-37, 62) explains that the asymmetry in the EPA model is due to the slopes of the LM curve and the degree of bond substitutability.

foreign income therefore increase.[12] In the majority-case where a fiscal expansion appreciates the currency, the positive transmission to foreign output provides a preliminary indication that the four theoretical contractionary effects of a currency depreciation discussed above (via money balances, real wealth, imported input prices or wages) either are not operating, or at least are not powerful enough to reverse standard transmission results.

The one exception to positive transmission among the eleven structural models is the Liverpool model. Though lining up with the majority on the positive effect of a fiscal expansion on the value of domestic currency, the negative effect on the domestic current account, and positive effect on the foreign current account, the Liverpool model nevertheless produces the unique result of a negative effect on foreign output. The reverse transmission holds both from the United States abroad (weakly) and in the opposite direction (more strongly). Evidently one or more of the four contractionary exchange rate effects is operating. Minford (1984, eq. 2, pp. 88-89) specifies an adverse supply effect from depreciation, apparently justified along the lines of the last of the four effects enumerated above: an increase in wages, in

[12] In the VAR results, a fiscal expansion in either country produces a current account deficit in the other country. In the case of a U.S. fiscal expansion, the non-U.S. current account worsens slightly in the second year even though U.S. income rises, non-U.S. income falls, the dollar rises against foreign currencies, and the U.S. current account worsens! Such results suggest limitations to the usefulness of using non-structural models to answer questions about the likely effects of changes in policy. Cooley and Leroy (1985) consider this methodological issue.

nominal or own-product terms.[13] The Liverpool simulations show a sharper increase in the CPI of the country not undertaking the fiscal expansion, presumably as a result of the depreciation of its currency, than do the other models. This could explain the strength of the adverse supply effect in that model.

It is not surprising that the one model that shows the most dissimilar results is nonstructural: the Sims-Litterman VAR model. Like the Liverpool model it shows no positive transmission from U.S. fiscal policy to non-U.S. output (the effect appears to be inverse in the first two years, but insignificant to the third digit). More anomalously it shows a fiscal expansion in either country reducing the price level P in both countries (GNP deflator).[14]

To sum up the results of fiscal expansion, all structural models show negative effects on the domestic current account. All but one show positive effects on both domestic and foreign output. All but one show positive effects on the domestic price level. Several show a negative rather than positive effect on the value of the currency, especially when it is the non-U.S. OECD that is expanding. But the one case of negative transmission to foreign output is not one of the few, like the

---

[13] However, Marston (1984, 136) specifically describes Minford's exchange rate effect on supply as coming from imported inputs, not labor costs. (Neither wages nor imported inputs appear explicitly in the model.) Hooper (1986, 7) identifies the contractionary effect of the exchange rate in the Liverpool model as the real wealth effect.

[14] The Wharton model also shows the non-U.S. CPI declining in response to a fiscal expansion originating in either country, presumably due to a combination of markup pricing and procyclical productivity, as mentioned in footnote 9.

Wharton model, in which the domestic currency depreciates, which one would expect to weaken the transmission link through the trade balance. Rather, it is the Liverpool model, in which the domestic currency appreciates, raising the other country's CPI sharply with adverse effects on supply.

These conflicts regarding the exchange rate and transmission effects of fiscal policy are relatively few and within the bounds of standard theoretical results. (This does not include the VAR model which features anomolous effects on price levels, interest rates and current accounts.)

3. Monetary Policy Multipliers in the Simulations

Table 3 displays the effects of a monetary expansion equal to 4 percent of the money supply, phased in over the first year (Simulation D for the United States and H for the rest of the OECD). The simulation findings for the effects of monetary policy show more conflict among the models, and the conflict is less in line with well-known theoretical ambiguities, than for the effects of fiscal policy. The models divide almost evenly on the transmission of a U.S. monetary expansion to the rest of the OECD. All models show a clear depreciation of the dollar. The MCM, EPA, LINK, Liverpool, Minimod, Taylor and DRI models show the standard Mundell-Fleming result that the appreciation of foreign currencies causes the foreign incomes to decline, though only the Minimod shows the complete Mundell-Fleming story of the domestic current account improving, foreign current account worsening, and as a result foreign output declining. The EEC, VAR, MSG, OECD and Wharton models show positive transmission instead. When the monetary expansion originates in the non-U.S. OECD, positive transmission occurs not only in those

Table 3. 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

five models but also in EPA, LINK, and Liverpool. In other words, the Mundell-Fleming transmission result is reversed in 8 out of 11 models.

The obvious explanation for a rise in foreign income in response to a domestic increase in the money supply and exchange rate is that the appreciation of the foreign currencies has one or more of the expansionary effects abroad enumerated above: increasing the real money supply and real wealth or decreasing wages and imported input costs. If any of these expansionary effects is strong enough to dominate the change in the trade balance, we could get the positive transmission. The primary obstacle to attaching this interpretation to the models is that in the Brookings simulations for the case of a non-policy depreciation of the dollar (Simulation F), eight of the ten models show a clear negative effect on foreign income. The only one to show a clear expansionary effect, despite the worsening in the foreign trade balance, is the Minimod model, which is not one of those showing positive transmission of monetary expansion. This suggests that the observed positive transmission of a U.S. monetary expansion to foreign income occurs through some channel other than the exchange rate.

In the case of the EEC, OECD and Wharton models, the channel of the transmission of a U.S. monetary expansion is easily identified: despite the depreciation of the dollar, the U.S. current account worsens and the foreign current account improves. Puzzlingly, the worsening in the U.S. current account occurs not only in the three models in which non-U.S. output rises, but also in five of the models in which non-U.S.

output falls: the MCM, EPA, LINK, Liverpool, and DRI models.[15] In the case of the MCM and EPA models, the non-U.S. current account worsens even though the U.S. current account worsens,[16] while in the other three, non-U.S. output falls even though the non-U.S. current account improves; either breaking of the trade transmission link seems quite difficult to explain.

The surprise contained in the deterioration of the U.S. trade balance in 8 out of 11 of the models is not the fact that the dollar depreciates. Higher U.S. income accounts for higher imports, and Simulation F, the "non-policy exogenous depreciation of the dollar," reveals that several of the models have a prolonged enough J curve that the trade balance does not respond positively to the exchange rate until the third or fourth year (Wharton, OECD, and LINK). The puzzle from the viewpoint of the Mundell-Fleming model is rather how the net capital inflow, which must equal the trade deficit under floating exchange rates, can increase after a monetary expansion. The monetary expansion should decrease the U.S. interest rate (except, of course, in models where there are lags in neither expectations nor price adjustment). In the simulations, the interest rate does indeed decrease,

---

[15] Oudiz and Sachs (1984, 20-22) report that monetary expansion worsens the domestic current account, for the EPA model as well as the MCM model (for either the U.S., Japan, or West Germany). Yoshitomi (1984, 347-350, 396) confirms this property of the EPA model.

[16] The U.S. and non-U.S. current accounts move the same direction for the VAR model as well. In a well-specified two-country model such results would be impossible. Since the simulation results include only the larger countries, it is conceivable that the total U.S. and non-U.S. current accounts could change vis-a-vis excluded countries like OPEC.

though for most models the nominal interest rate has already begun to start back up by the second year.[17] The Mundell-Fleming theory under floating exchange rates says that the lower interest rate should induce a capital outflow, implying a sufficiently strong currency depreciation to improve the current account correspondingly.[18] The models in the simulations seem to be behaving more like models of fixed (or managed) exchange rates, where an increase in the money supply flows out of the country through a trade deficit financed out of foreign exchange reserves, than like models with no intervention in the foreign exchange market.

Helliwell and Padmore (1985, 1130-31) and Helliwell (1986, 15) have identified why some of the large econometric models have the property that a monetary expansion causes a net capital inflow. Capital flows respond not only to interest rates but also to expectations of future exchange rate changes. If the instantaneous depreciation of the currency, which results from a monetary expansion, generates expectations of future appreciation back toward long-run equilibrium, then it will have a positive effect on the attractiveness of domestic assets

---

[17]Again the Liverpool model is the exception: the interest rate rises in the first year and falls in the second. But even in this model, it is lower in the second year relative to the zero baseline.

[18]In models of perfect capital mobility, the ex ante decrease in demand for dollar assets, which leads to the depreciation of the currency, is not the same thing as an ex post decrease in the net capital account balance. But if perfect capital mobility ties the domestic interest rate to the foreign interest rate, then it means the trade balance must improve even more (by enough so that the higher transactions demand absorbs all the increased money supply, with no help from lower interest rates, except via large-country effects).

that runs counter to the lower interest rates. In Helliwell's terms, speculative capital flows fulfill the stabilizing "buffer stock" role that official intervention would play under a system of fixed or managed exchange rates. This regressive type of expectation has been found to be rational in the Dornbusch (1976) overshooting model and some other versions of the asset market approach to exchange rate determination. Its properties in the Mundell-Fleming approach to the capital account are somewhat less well-known, though stated by Mussa (1979, 191).[19] It is clear that many as yet unresolved research issues continue to fall under the heading of understanding expectations and the capital account.

The positive transmission to foreign real GNP requires a second modification of the Mundell-Fleming model, in addition to the capital account. For the foreign money market equilibrium condition (2) to hold with no change in the foreign money supply, and with a fall in domestic and foreign interest rates, the foreign price level must fall despite the rise in foreign real GNP. The foreign CPI and GNP deflator both do fall in most of the model simulations, because of the appreciation of foreign currencies.[20] Indeed, in half the models in which foreign real GNP rises, foreign nominal GNP nevertheless falls.

---

[19]Yoshitomi (1984) emphasizes the importance of regressive exchange rate expectations in potentially reversing the direction of capital flows. Among the other models that now incorporate the regressive exchange rate expectations of Dornbusch (1976) are the MCM model (Haas and Symansky (1984)) and Minimod. The MSG model, Minford (1984, 90,97), and Taylor (1985, 56) make the assumption that efficient market arbitrage drives the interest differential to the rationally expected rate of depreciation; but only MSG shows the exchange-rate overshooting that is required if regressive expectations are to be rational.

[20]I am indebted to Gerry Holtham and Warren Trepeta for this point.

To sum up the results of monetary expansion, almost as many models show positive transmission to the rest of the OECD as show negative transmission, and a majority show positive transmission from the rest of the OECD to the United States. Their reversal of the Mundell-Fleming result is not attributable to non-trade effects of the exchange rate on foreign income. Rather it is usually due to a trade balance shift in favor of the foreign country. In terms of target variables of interest to the domestic country, the effect of a monetary expansion on the trade balance is the issue on which the models disagree the most. Several of the models feature a non-interest rate related capital flow into the domestic country--contrary to Mundell-Fleming--allowing the monetary expansion to worsen the trade balance. It is striking how little resemblance such simulation results bear to the picture presented in the theoretical literature.

References

Argy, Victor; and Salop, Joanne. "Price and Output Effects of Monetary and Fiscal Policy under Flexible Exchange Rates." IMF Staff Papers. (1977): 224-256.

________. "Monetary and Fiscal Expansion in a Two Country World under Flexible Exchange Rates." IMF, May 1979.

Branson, W. and W. Buiter. "Monetary and Fiscal Policy with Flexible Exchange Rates." In Economic Interdependence and Flexible Exchange Rates. Edited by J. Bhandari and B. Putnam. Cambridge: M.I.T. Press, 1983.

Branson, W.; and Rotenberg, J. "International Adjustment with Wage Rigidity." European Economic Review 13.3 (May 1980): 309-337.

Bruno, Michael; and Sachs, Jeffrey. Economics of Worldwide Stagflation. Cambridge: Harvard University Press, 1985.

Cooley, Thomas; and LeRoy, Stephen. "Atheoretical Macroeconometrics: A Critique." JME 16 (1985): 283-308.

Dornbusch, Rudiger. "Expectations and Exchange Rate Dynamics." J. Political Economy (Dec. 1976).

Girton, Lance; and Henderson, Dale. "Financial Capital Movements and Central Bank Behavior in a Two-Country, Short-Run Portfolio-Balance Model." J. Monetary Ec. 2 (1976): 33-61.

Haas, Richard; and Symansky, Steven. "Assessing Dynamic Properties of the MCM: A Simulation Approach." Federal Reserve Board, Int. Fin. Discussion Paper No. 214, January 1983.

Helliwell, John. "Empirical Macroeconomics for Interdependent Economies: What Next?" Paper prepared for conference at Brookings, March 10-11, 1985.

Helliwell, John; and Padmore, Tim. "Empirical Studies of Macroeconomic Interdependence." In Handbook of International Economics, Vol. II. Edited by R. Jones and P. Kenen. Amsterdam: North Holland, 1985.

Henderson, Dale. "Canadian Post-War Balance of Payments and Exchange-Rate Experience: Comment," in Douglas Purvis, ed., The Canadian Balance of Payments: Perspectives and Policy Issues. The Institute for Research on Public Policy, 1983.

Hickman, Bert. "The U.S. Economy and the International Transmission Mechanism: A Structural Comparison of Twelve Multicountry Models." Center for Economic Policy Research Paper No. 78, Stanford University, July 1986. This volume.

Hooper, Peter. "Summary Description and Analysis of Comparative Model Simulations." 1986. This volume.

Laursen, S. and L. Metzler. "Flexible Exchange Rates for the Theory of Employment," Review of Economics and Statistics, 32 (November 1950), pp. 281-289.

Marston, Richard. "The Effects of American Policies - A New Classical Interpretation: Comment." In International Economic Policy Coordination, pp. 134-38. Edited by W. Buiter and R. Marston. Cambridge: Cambridge University Press, 1984.

Minford, Patrick. "The Effects of American Policies - A New Classical Interpretation." In International Economic Policy Coordination, pp. 84-126. Edited by W. Buiter and R. Marston. Cambridge: Cambridge University Press, 1984.

Mundell, Robert. "A Reply, Capital Mobility and Size." Canadian Journal of Econ. and P.S. 30 (1964).

Mussa, Michael. "Macroeconomic Interdependence and the Exchange Rate Regime." In International Economic Policy: Theory and Evidence. Edited by R. Dornbusch and J. Frenkel. Baltimore: Johns Hopkins, 1979.

Obstfeld, Maurice. "Aggregate Spending and the Terms of Trade: Is There a Laursen-Metzler Effect?" QJE 96 (May 1982).

Oudiz, Gilles; and Sachs, Jeffrey. "Macroeconomic Policy Coordination among the Industrial Economies." Brookings Papers on Economic Activity. (1984): 1-76.

Sachs, Jeffrey. "Wages, Flexible Exchange Rates, and Macroeconomic Policy." QJE (1980): 731-47.

Stevens, Guy et al. The U.S. Economy in an Interdependent World: A Multi-Country Model. Federal Reserve Board.

Svensson, Lars; and Razin, Assaf. "The Terms of Trade and the Current Account: The Harberger-Laursen-Metzler Effect." JPE 91, no. 1 (February 1983): 97-125.

Swoboda, Alexandre; and Dornbusch, Rudiger. "Adjustment Policy and Monetary Equilibrium in a Two-Country Model." In International Trade and Money. Edited by M. Connolly and A. Swoboda. London: George Allen & Unwin, 1973.

Taylor, John. "International Coordination in the Design of Macroeconomic Policy Rules." European Ec. Rev. 28 (1985): 53-81.

Yoshitomi, Masaru. "The Insulation and Transmission Mechanisms of Floating Exchange Rates Analyzed by the EPA World Econometric Model." In EPA World Economic Model. Edited by Yoshitomi et al. Tokyo: Economic Planning Agency, 1984.

The Implications of Conflicting Models for Coordination Between Monetary and Fiscal Policy-Makers*

Revised October 6, 1986

Jeffrey A. Frankel
Department of Economics
University of California
Berkeley, CA 94720

ABSTRACT

This paper examines the implications of conflicting estimates of macroeconomic multipliers for international policy coordination. The existing literature makes the unrealistic assumption that policy-makers all know the true model, from which it follows that the Nash bargaining solution is in general superior to the Nash competitive solution. But everything changes once we recognize that policy-makers' models, as the models in the Brookings simulations, differ from each other and therefore from the "true" model. When the central bank and fiscal authorities subscribe to conflicting models, it is still true that (1) the competitive equilibrium is sub-optimal, and that (2) the two authorities will in general be able to agree on a cooperative policy package that each believes will improve the objective function; however, (3) 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. Out of 1,210 possible combinations of different models subscribed to by the two policy authorities and models representing reality, bargaining raises welfare in only 728 cases. The conclusion is that disagreement as to the true model may be a more serious obstacle to successful policy coordination than is institutional failure to enforce Pareto-improving solutions.

*Forthcoming, Empirical Macroeconomics for Interdependent Economies edited by Ralph Bryant and Dale Henderson (Brookings Institution: Washington, D.C.). This paper is a revised version of the second half of NBER Working Paper No. 1925. The author would like to thank Katharine Rockett for capable research assistance.

1. Introduction

An easy way for an outsider to tell when an academic discipline has not yet ascertained "the truth" is when its practitioners each give different answers to the same question. We know that we as macroeconomists have not yet ascertained "the truth," if there was previously any doubt on this score, when we look at the great divergence in forecasts as to the effects of carefully-specified policy changes in the Brookings simulation exercise "Empirical Macroeconomics for Interdependent Economies". The probability that a given model is correct is small, when the number of models giving different answers is large. Furthermore it is unlikely that we will ever discover the true model; the number of different models and the way models keep changing over time is evidence of this proposition, and it seems inherent in the nature of social science.

There are three ways research can proceed. The first is for the researcher at each point in time to maintain that he or she has now discovered the one true model, and that all other models are wrong. The second is for the researcher, while continuing to speak the language that suggests his model is the one true one, to recognize implicitly that this language is merely a convenient shorthand. The third is to focus explicitly on the co-existence of conflicting models.

The second research strategy is the best one to pursue for most economic problems. The econometrician knows that his parameter estimates are not exactly correct. More generally, all modellers know that their models must be incomplete and misspecified. Nevertheless, if the economist is good, the errors in his model will be such that, even if they could be correctly handled, it would not much change his forecasts (in the case of an econometric forecasting model) or the conceptual point he is trying to make (in the case of a theoretical model). While it may be useful for the modeller to have explored as many extensions as possible in appendices and such, there is not a need for him to be able to claim that he has exhausted the truth. Nor is there a need for him, on the other hand, to make frequent disclaimers; the readers will understand that the model is not to be taken as literal truth.

These issues become most salient where, as in most modern macroeconomic models, agents in the proposed model must make decisions based on expectations formed from some model of their own. The rational expectations assumption is, of course, the assumption that the model used by the agents is the same as the proposed larger model. As soon as we admit that--because intelligent people are observed to believe in conflicting models--we cannot claim that the proposed larger model necessarily is literal truth, it follows that we cannot claim that agents' models must necessarily be literally identical to the proposed larger model. But, again, for many economic problems, especially those involving the microeconomic decisions of private agents, one can make a case that there is little to be gained by explicitly focusing on divergent models. The assumption that the agents know the one true model will continue to be an attractive modelling strategy.

When the decision makers are governments and the decision variables are macroeconomic policies, the case for assuming that everyone knows the one true model is less compelling. In the first place, there is no powerful force like the marketplace to discipline governments who use incorrect models. In the second place, the Federal Reserve Board's MCM model, the Japanese EPA model, the OECD Interlink model, etc., are the best that these government agencies have, and we can see that these models conflict. One can argue that microeconomic agents have access to specific knowledge of a common model unavailable to the macroeconomist. It would be more difficult for a macroeconomist at a government agency to argue that policymakers at his or her own agency have access to knowledge of a common model unavailable to the macroeconomist himself.[1]

It is a general principle of the existing literature on macroeconomic policy coordination that, when two policy-makers both affect variables that each cares about, they can do better by cooperating than they would in the Nash equilibrium, in which each acts to maximize his own welfare function taking the actions of the other as given.[2] This principle has led economists to propose increased coordination between different domestic policy-making agencies, and

---

[1]This is not to make the naive mistake of thinking that policy makers put complete faith in the models of the macroeconomists at their own agencies, nor that the latter necessarily have access to the latest data and thoughts of the former. But policy makers, at best, base their thinking on models--whether developed by government, academic or corporate institutions--similar to those in the Brookings modelling exercise. (For example, British macroeconomic policy under Thatcher may have been based on a model closer to the Liverpool model, which appears in this exercise, than to any models previously existing at the U.K. Treasury or Bank of England.) Policymakers, more likely, base their thinking on "models" that conform even less to each other or to truth than do the models of macroeconomists.

[2]This paper is not the first to develop an exception to this principle. One counterexample (along very different lines) is offered by Rogoff (1985). For good introductions to the coordination literature, see Oudiz and Sachs (1984) or Cooper (1985).

between domestic and foreign policy-makers. An example of the first type from the 1980s is the argument that the Federal Reserve should agree to follow a looser monetary policy in return for the Administration (and Congress) agreeing to reduce the federal budget deficit. The point would be to reduce interest rates, the value of the dollar and the trade deficit, without losing anything in the output/inflation tradeoff. An example of the second type is the argument that the United States should agree to follow a tighter budget policy in return for Europe and Japan agreeing to move in the opposite direction.[3] The point, again, would be to reduce the trade imbalance without causing a world recession.

The existence of conflicting models gives the literature on international coordination a certain air of unreality. To begin with, the issue of the gains from coordination is subtle enough that, even among economists who agree on the broad outline of the correct model, small differences can lead to opposite recommendations as to the direction in which policy-settings must be moved to reap the gains from coordination. An example in domestic U.S. policy-making is that movement in the direction of a tight monetary policy and a loose fiscal policy, far from being the outcome of a destructive lack of coordination between the monetary and fiscal authorities, might be thought desirable from the national point of view: the high value for the dollar reduces the U.S. Consumer Price Index and thereby allows an improvement over the

---

[3]For example, Layard et al (1984) and Marris (1985).

regular output/inflation tradeoff.[4] Examples in the international context abound. OECD countries are often urged to undertake a coordinated expansion; the argument is that each is reluctant to expand on its own for fear of worsening its trade balance and/or currency value.[5] On the other hand there has been talk about the need for coordinated monetary discipline (particularly in the 1970s) and coordinated budgetary discipline (particularly in the 1980s). It seems that every possible combination has been suggested: the Nash non-cooperative equilibrium is variously thought to result in competitive currency appreciation, competitive currency depreciation ("beggar-thy-neighbor"), insufficient expansion, or excessive expansion. It has even been suggested that the gains from international coordination lie in an agreement that one country will expand whenever others are contracting and vice versa.

If such contradictions are possible within the standard models of mainstream macroeconomists,[6] the situation is even worse once the more widely-scattered views of policy makers are acknowledged. In the context of 1983-1984, there was little point in trying to convince the U.S.

---

[4]Sachs (1985), for example, has offered this interpretation of the U.S. monetary/fiscal mix in the early 1980s--that it might have been optimal given the objective function.

[5]One of many examples from the 1980s is Bergsten et al (1982). The gains from coordinated expansion by Europe, Japan and the United States were also behind the locomotive theory that led to the 1978 Bonn Summit.

[6]Some of the conflicting possibilities arise from uncertainty as to what are the variables that should enter the objective function and where the economy currently is relative to the optimum, rather than uncertainty as to the correct model or parameter values. The economist could plausibly argue that such questions can only be answered by the political process.

Treasury that, to correct the exchange rate and trade imbalance, the United States should reverse its fiscal expansion in exchange for European and Japanese fiscal expansion. The Treasury view was that there had been no U.S. fiscal expansion to begin with, that fiscal expansion causes currencies if anything to depreciate, that the strength of the dollar was instead attributable to other factors (the "safe-haven" effect), that the trade deficit was in any case not attributable to the strong dollar (but rather to rapid U.S. growth), and--most relevantly--that the Administration did not want Europe and Japan to undertake fiscal expansion.

The purist will argue that if policy makers have different "information," then they "should" share it with each other and agree on a common model. The proposition about gains from coordination holds regardless of which model is correct.[7] In practical terms, then, the purist is urging on economists a research strategy of first discovering and agreeing on the true model, and only then convincing policy makers that it is the true model (a task that would surely be less difficult if macroeconomists agreed among themselves) and pointing out the gains from coordination based on this true model.

Research will, and should, proceed with the aim of developing models that more closely reflect economic reality. Most of this

---

[7]Some authors, such as Canzoneri and Gray (1983), set up their theory in a framework general enough to encompass all of the possible positive or negative effects. The direction in which policies must be moved in order to reap gains from coordination can be viewed as a function of the parameter values, the latter presumably to be filled in later by the econometrician.

research will, and perhaps should, proceed under the assumption that actors within the model act on the basis of the model itself. But there is also a need for research under the assumption that actors have different models. These are the only circumstances under which policy-making is likely to take place.

In this paper, we consider the domestic problem in which the two policy makers are the monetary authority and the fiscal authority. In a sequel paper we consider the international problem, in which the policy makers are the U.S. authorities on the one hand and European and Japanese authorities on the other.[8] The findings in the international context are quite similar to the findings reported here. In both problems, the 12 models that participated in the Brookings simulations are used to illustrate the conflicting beliefs that policy makers could have, and their implications for coordination.

We will consider here what happens when the monetary and fiscal authority have identical welfare functions, so as to focus on the role of divergent models in policy conflict and coordination. In the case of international coordination the policy-makers clearly have different welfare functions,[9] but there is no reason why this should necessarily be true in the domestic case.

---

[8] Frankel and Rockett (1986).

[9] In the appendix to Frankel (1986), the NBER Working Paper version of this paper, the monetary authority is assumed to care about one variable (internal balance or external balance) and the fiscal authority to care about the other. This is the classic "Assignment Problem." But when each has only a single target variable, the optimum is attained in Nash equilibrium and there is no issue of a separate cooperative equilibrium. In Frankel and Rockett (1986), coordination arises out of both conflicting perceptions, as in the present paper, <u>and</u> conflicting targets, as in the standard literature.

2. The Theory of Coordination When Policy-Makers Disagree (Only) About the Model

We begin by showing how the monetary and fiscal authorities will prefer a cooperative equilibrium to the Nash non-cooperative one despite an identical welfare function, if they subscribe to different models. We will also show how, if neither of the policy makers happens to have the correct model, the cooperative equilibrium could as easily be inferior to the Nash equilibrium as the other way around, that is, could result by the light of the true model in a lower value of the agreed-upon welfare function.

When we study international coordination, each country must have more than two goals; otherwise it can use its two instruments, domestic monetary and fiscal policy, to attain both goals regardless what the other country does, and no interesting issue of coordination arises. But here we consider domestic coordination and limit the welfare function to two goals for simplicity. Let y be the log of domestic output and x be the current account as a share of GNP, both expressed as deviations from their desired or sustainable long-run levels. (In computations of the sort performed in this paper, we have also tried the exchange rate and the CPI for the second goal). The framework shared by all is the familiar linear one of targets and instruments:

$$y = A + Cm + Fg \qquad (1)$$

$$x = B + Dm + Gg \qquad (2)$$

Subscripts on the upper case letters, the policy multipliers, will indicate the different values they can take depending on the model: a "c" to represent the perceptions of the central bank, and an "f" to represent the perceptions of the fiscal authority. We adopt the conventional assumption that policy makers seek to minimize a quadratic loss function w:

(3) $$w = y^2 + \omega x^2$$

To ascertain the behavior of the central bank we differentiate the loss function with respect to m, with subscripts on the multipliers. The first order condition is:

(4) $$m = -I_c - J_c g ,$$

$$\text{where} \quad I_c \equiv \frac{C_c A_c + \omega D_c B_c}{C_c^2 + \omega D_c^2}$$

$$\text{and} \quad J_c \equiv \frac{C_c F_c + \omega D_c G_c}{C_c^2 + \omega D_c^2}$$

To ascertain the behavior of the fiscal authority, we take the derivative with respect to g. The first order condition is

(5) $$g = -K_f - L_f m ,$$

$$\text{where} \quad K_f \equiv \frac{F_f A_f + \omega G_f B_f}{F_f^2 + \omega G_f^2}$$

$$\text{and} \quad L_f \equiv \frac{C_f F_f + \omega D_f G_f}{F_f^2 + \omega G_f^2}$$

If both policy makers knew the true model, all subscripts could be dropped. The optimal solution in terms of the true parameters would then follow by solving the two equations simultaneously for g and m. There would be no issue of conflict or coordination, each agency simply doing its agreed-upon part.

But if the policy makers believe in different models, the subscripts must remain. The first equation has been solved for m as a function of g and the second vice versa, so that they represent the two authorities' reaction functions to each other's policies. The Nash non-cooperative equilibrium is:

$$m^n = \frac{-I_c + J_c K_f}{1 - J_c L_f} \tag{6}$$

$$g^n = \frac{-K_f + L_f I_c}{1 - J_c L_f} . \tag{7}$$

Assume the central bank believes in model 1. In Figure 1 we graph its reaction function CB1, as represented by equation (5). We draw it downward-sloping (a positive J_c); this would follow when, as in many of the models, m and g both have positive effects on income and both have negative effects on the current account. The central bank's perceived indifference curves radiate out from its perceived optimum, point 1. They are intersected by CB1 wherever they are flat, because along CB1 the central bank is optimizing with respect to m for a given g.

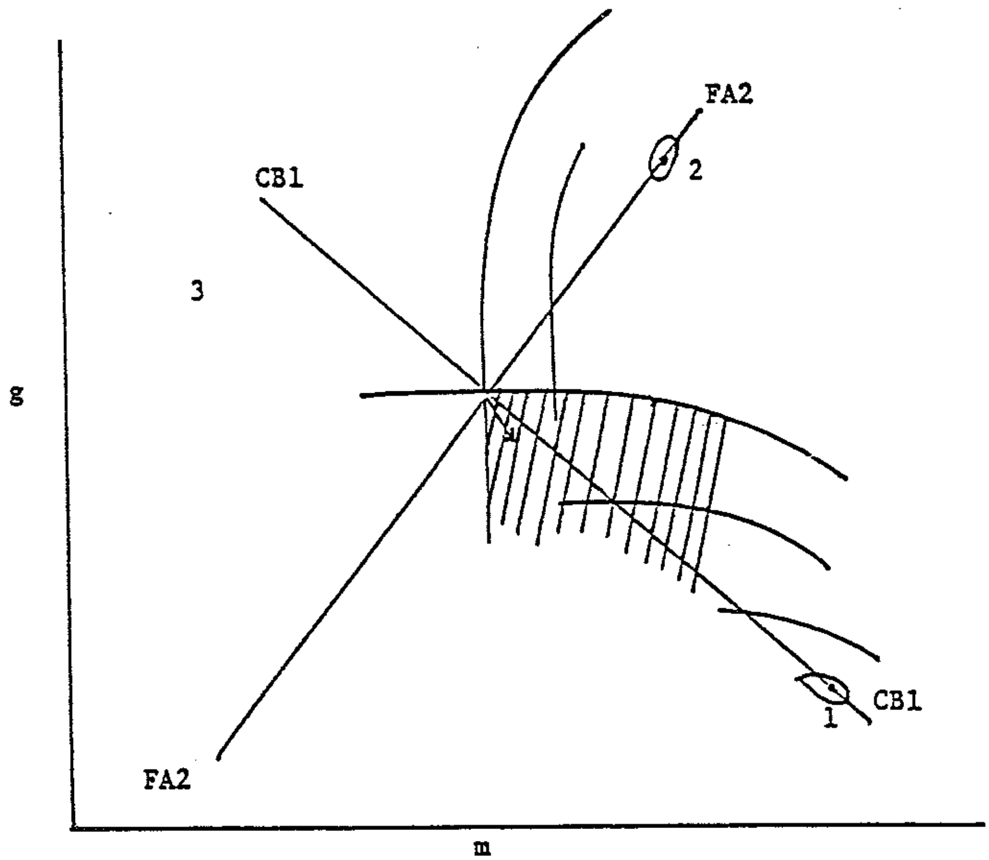

Figure 1: The Nash Competitive Equilibrium

If the fiscal authority also believed in model 1, then its reaction function FA1 would also pass through point 1. But let us assume the fiscal authority believes in model 2. We draw its reaction function FA2 upward-sloping (a negative L_f). This slope might follow if the fiscal authority's model differs from model 1 by featuring a positive current account multiplier for the money supply D_f, as in the MSG, Minimod, and VAR models in the case of U.S. monetary policy (the MCM, Liverpool, Minimod, VAR and Wharton models in the case of non-U.S. monetary policy).[10]

The fiscal authorities' perceived indifference curves radiate from its perceived optimum, point 2. They are intersected by FA2 wherever they are vertical, because along FA2 the fiscal authority is optimizing with respect to g for a given m. The Nash non-cooperative equilibrium is where the two reaction functions intersect, point N. We assume in this paper that the two policy-makers know what each other's beliefs are, so that they jump directly to equilibrium at N.[11] If the

---

[10]If the second target variable were the exchange rate instead of the trade balance, then the ambiguous effect of a fiscal expansion discussed previously could change negative slopes to positive. If it were the price level, then the negative effect of a monetary expansion in the LINK model or of a fiscal expansion in the VAR model could have the same implication. However, the points to be made here, particularly that coordination need not improve welfare, require only that the parameter values differ; they need not differ enough to give opposite-signed slopes.

[11]There is a potential issue of stability. If the policy-makers are thought of as taking turns reacting to each other according to (4) and (5), will they actually reach the Nash equilibrium point? Stability requires that the absolute value of the slope of CB1 exceed the absolute value of the slope of FA2. If the condition is satisfied, there is a second question of whether convergence to equilibrium will be slow or rapid.

two policy makers happen to have the same model, then point 1 = point 2 = point N.

It is very easy to see that the Nash solution represented by (6) and (7) is not the optimum. (One would need $I_c = I$, $K_f = K$, $J_c = J$ and $L_f = L$, where the unsubscripted letters are defined analogously to the subscripted ones so as to represent parameter values in the true model, for the Nash solution to be the optimum.) Neither policy maker will be happy with this equilibrium, each cursing the stupidity of the other for not moving in the desired direction. As we have drawn Figure 1, the fiscal authority wishes that the central bank would increase money growth, so as to depreciate the currency and improve the current account. But the central bank's perception is different, that increasing money growth would worsen the current account. It wishes the fiscal authority would decrease government spending.

One might think that when two policymakers have conflicting views as to the effects of any proposed package of policy changes, they would simply fail to come to an agreement to coordinate. But even assuming that neither policymaker is willing to revise his beliefs, there will in general be a bargain they can make that will raise the perceived welfare of each. In Figure 1 the authorities' indifference curves at N have slopes of zero and infinity, respectively, from which it follows that they are not tangent. They can both agree to move in the southeast direction. There is an entire range of points, those in the shaded "lens," that dominate N for both policy makers. Which point will they actually agree on? Much of the literature singles out the Nash bargaining solution, at which the product of the two agents welfare gains is maximized relative to what perceived welfare would be at the Nash competitive solution N12.[12] The bargaining solution is represented by a point on the contract curve like the one labelled B12 in figure 2. We would choose m and g to maximize

$$(8) \qquad \left(W_c(m,g) - W_c(m^n,g^n)\right)\left(W_f(m,g) - W_f(m^n,g^n)\right)$$

$$= \Big([(A_c + C_c m + F_c g)^2 + \omega(B_c + D_c m + G_c g)^2] - [(A_c + C_c m^n + F_c g^n)^2 + \omega(B_c + D_c m^n + G_c g^n)^2]\Big)$$

$$\Big([(A_f + C_f m + F_f g)^2 + \omega(B_f + D_f m + G_f g)^2] - [(A_f + C_f m^n + F_f g^n)^2 + \omega(B_f + D_f m^n + G_f g^n)^2]\Big).$$

Notice that the analytics of maximizing the two agents' welfare functions are the same as in the standard coordination problem. One could not tell from equation (8), if one did not know, that the parameters refer to different perceptions of the same multipliers, rather than similar perceptions of different multipliers.

The usual enforcement problems exist as well: each would prefer to cheat on the bargain. We will ignore issues of repeated games, credible commitment, etc., and content ourselves for the purposes of this paper with comparisons of the static cooperative and non-cooperative solutions.

---

[12] e.g. Oudiz and Sachs (1984, 36-37). When speaking of the product of the gains we mean them to be positive. And we rule out side-payments.

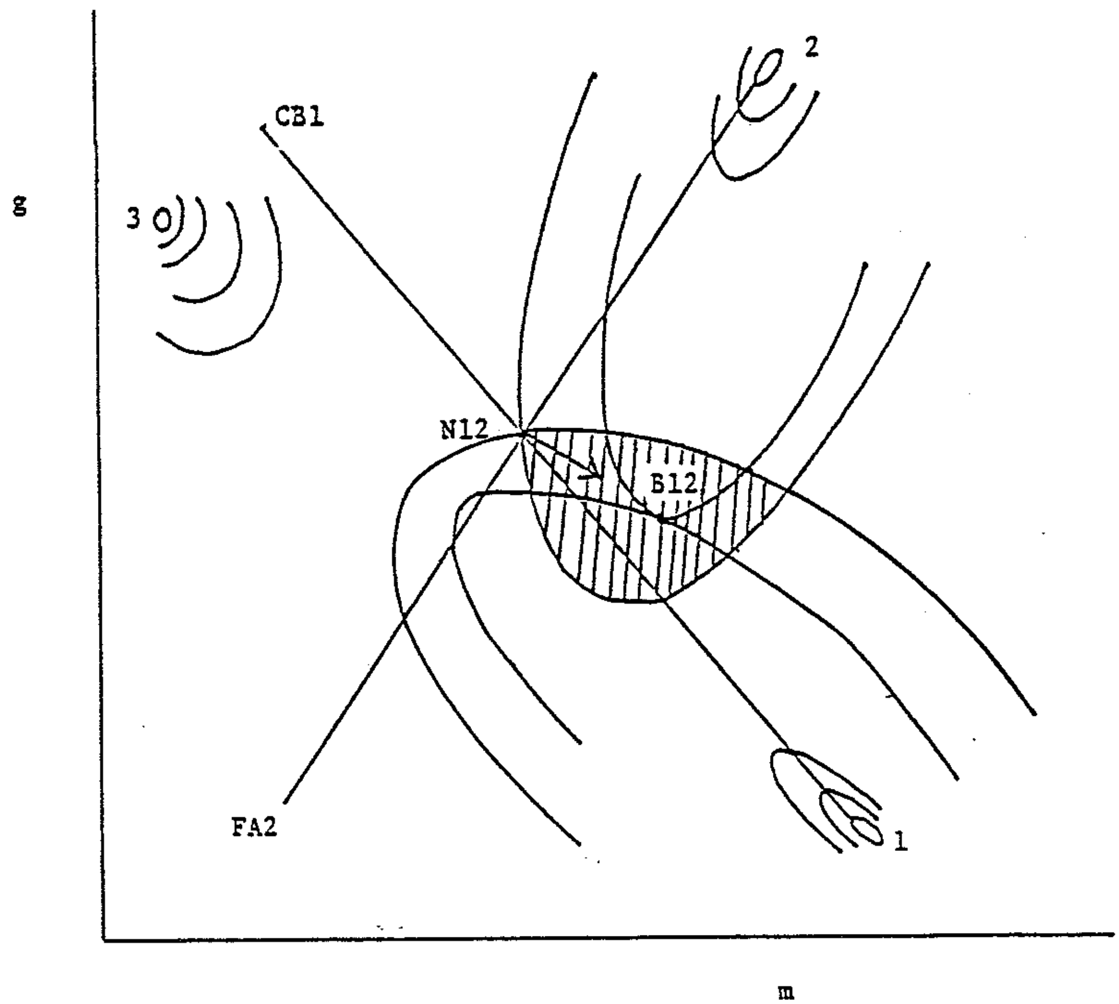

Figure 2: Policy Coordination

One possible alternative to the Nash bargaining point as a cooperative solution for the problem of conflicting models would be for the policy makers to "bargain" over what is the correct model. In the event of widely diverging Bayesian priors, it would probably take a prohibitively great amount of new data for the two to reach a genuine convergence of beliefs. But for the sake of compromise, in an attempt to improve on the competitive equilibrium N12, they could agree to base their policy actions on a version of equations (1) and (2) in which the parameter estimates are taken as a weighted average of their individual parameter estimates. If one wished to preserve the symmetry that characterizes the Nash bargaining solution (8), the weights could be equal, although this seems ad hoc.

A possibility for future research is to compare the implications of a strategy of averaging the parameter estimates to the implications of the usual Nash bargaining point. As a positive, rather than normative, solution concept, it has the disadvantage that it could lie outside the shaded lens, that is, it could result in one policy-maker's perceived level of welfare being less than it would be at point N12. But if the average of two parameter estimates is a better estimator of the true parameter value than either alone, as is often the case in statistics, then it might be possible to show that the averaging solution would result in a higher expected value of welfare as judged by the true model than the Nash bargaining solution. The prescriptive conclusion would be that ministers in OECD meetings should spend less of their time telling each other how to change their policies and more of their time discussing the basic assumptions underlying their views of the world.

Our major question here is whether movement of the policy settings in the direction that raises each policy maker's perceived welfare, for example movement to the bargaining point B12, does in reality affect y and x in such a way as to improve welfare. The answer of course depends on the true model. If one or the other of the policy makers' models (1 and 2) happens to be the true model, then cooperation will necessarily improve welfare; otherwise that policy maker would not have agreed to the change. But, as we argued in the introduction, this is unlikely to be the case. More likely, reality is represented by some third model, say point 3 in Figures 1 or 2. The true welfare levels produced by various combinations of m and g are represented by the indifference curves radiating from point 3. As we have drawn it, cooperation turns out to reduce welfare, though it could as easily have been the reverse.

To see what other outcomes are possible, we can swap models. Figure 3 shows the possibilities. If the central bank believes model 3 instead of model 1 then its reaction function is given by line CB3. If the fiscal authority believes model 1, then the reaction line is given by FA1. The Nash competitive point is now N31 instead of N12. The two policy makers can raise the perceived welfare of each by agreeing to move in the northeast direction. If reality is represented by the same model 3 then cooperation necessarily improves welfare. But if reality is represented by model 2 instead of model 3, then the Nash point N31 must be judged by the standard of the indifference curves radiating from point 2. As we have drawn the graph, cooperation turns out to raise true welfare with this combination of models.

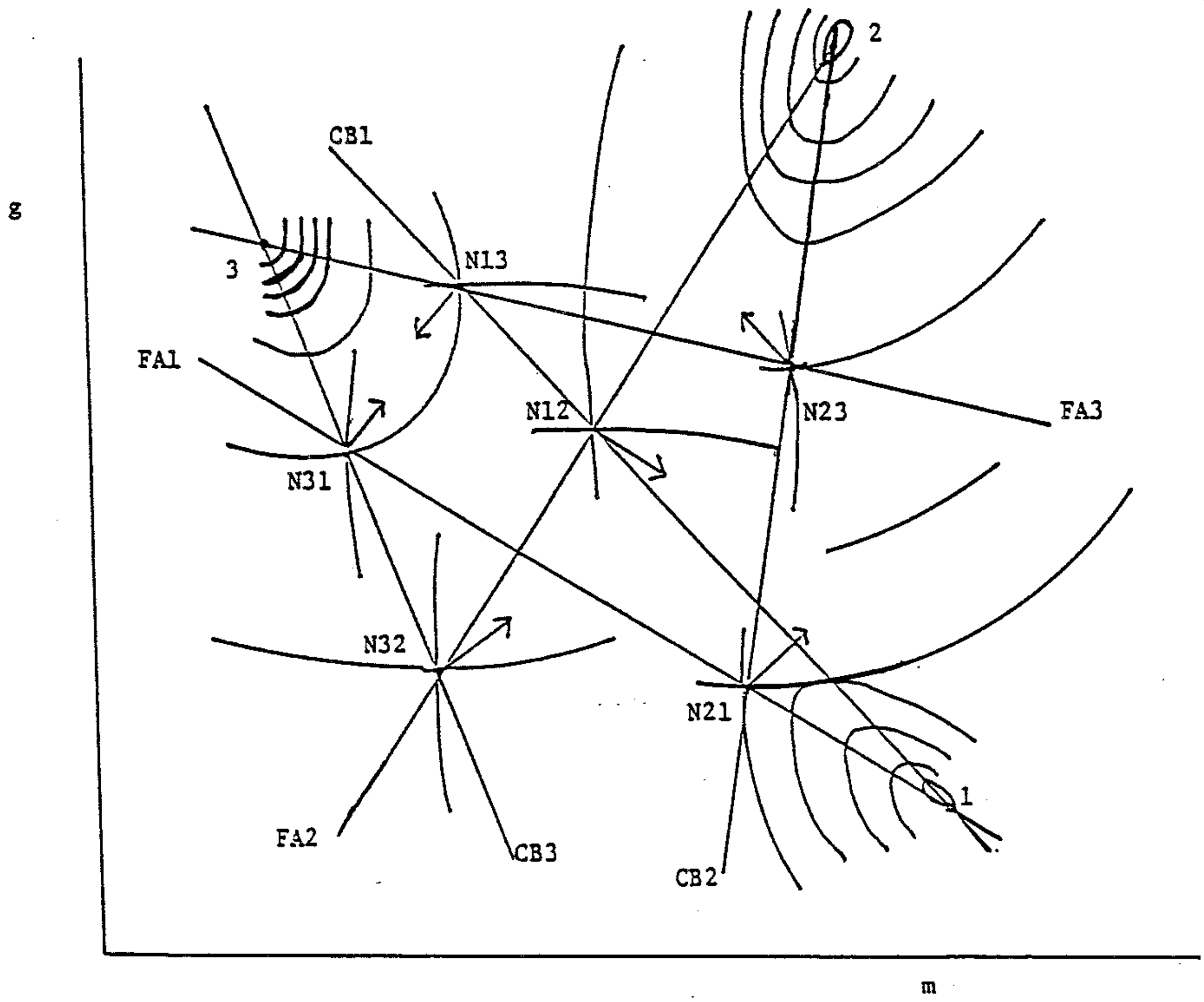

Figure 3: Possible Combinations of Three Models

Altogether there are twenty-seven (= 3 x 3 x 3) combinations: the fiscal authority can believe any of the three models, the central bank can believe any of the three, and reality can be represented by any of the three. In the 9/27 combinations where the two agencies happen to share the same model, coordination is not an issue one way or the other. Out of the remaining 18 combinations there are 12 in which one of the two agencies' models coincides with the true model; here coordination necessarily improves welfare. The remaining 6 combinations could go either way; when all three models are distinct, it seems that coordination could reduce welfare (as from point N12) as easily as improve it (from point N31). This case becomes more important as the number of distinct models becomes larger. If there are q models, there are $q(q-1)(q-2)$ combinations in which three different models are featured, out of a total of q^3 combinations. The limit as q goes to infinity, in which the probability of divergent models goes to 1, seems to describe the actual state of affairs.

3. Evidence from the Simulations

How important is the issue of conflicting models likely to be in practice? For example, is the case where coordination reduces welfare as judged by the true model merely a pathological counterexample? In what follows we use the simulation results of the international macroeconometric models that participated in the Brookings exercise to see what might happen. If we used all 12 models there would be 1728 ($=12^3$)

combinations. To keep the problem more manageable,[13] we first concentrate on 6 models (giving 216 combinations): the MCM, EPA, LINK, Liverpool, VAR and OECD models. The models were chosen to be representative of the full range of models both with respect to geography--one might choose to associate the MCM with U.S. beliefs, the EPA with Japanese beliefs, and the OECD with European beliefs--and with respect to philosophy--the LINK model being considered the most Keynesian of the twelve, Liverpool the most monetarist/new classical, and VAR the only non-structural model.

This study follows the path blazed by Oudiz and Sachs (1984). Indeed they listed uncertainty (though not disagreement) as to the correct model as one of the topics remaining for future research:

> "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....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." (p. 56)

Oudiz and Sachs calculated the effects of international coordination taking the policy multipliers from the MCM and EPA models. They noted differences between the econometric models, but maintained the usual assumption that the models used by both policy makers coincided with each other and with reality.

---

[13]It is as easy to program the computer to do 1728 combinations as fewer, and we offer the summary statistics below. But the output is too much to present in a table.

We take policy multipliers from the simulation results reported in Tables 2 (government expenditure) and 3 (money supply) in Frankel (this volume). These are the effects in the second year, chosen to represent the relatively short run, but allowing enough time to get past the negative part of the J-curve. For any experiments that envision the policy-makers acting in real time, one can imagine using dynamic multipliers, that is, the entire time profile of policy effects that was produced in the simulations; but this complication is left for future research. Table 1 reports the policy multipliers for an increase in government spending equal to one percent of GNP or one percent increase in the money supply: the effect on the level of GNP and the effect on the current account, both expressed as a percent of GNP. The first vector can be interpreted as the model estimates of the conventional textbook multiplier, the dollar increase in GNP per dollar increase in spending.

Computing the reaction functions (4) and (5) requires knowing not only the perceived policy multipliers, but also the relative welfare weight (ω) placed on the trade balance, and the perceived optimums for the income and trade-balance targets.[14] Even though we have decided here to attribute the same ω to both policy makers, in order to concentrate solely on conflicts in models, the value judgment remains an exceedingly difficult and arbitrary task. It seems that the calculation as to the location of the Nash point can be as sensitive to the choice

---

[14]Choosing the target optimums around which x and y are measured is equivalent to choosing the constant terms A and B.

TABLE 1

U.S. MULTIPLIERS IN THE SECOND YEAR

	Percentage effect on the level of income		Effect on the current account as a percentage of GNP	
	y		x	
	From a 1% increase in money	From an increase in govt. spending of 1% of GNP	From a 1% increase in money	From an increase in govt. spending of 1% of GNP
	C	F	D	G
Models				
MCM	0.3750	1.8000	-0.0198	-0.4217
EPA	0.3000	1.7000	-0.0102	-0.5233
LIVPOOL	0.0250	0.6000	-0.0832	-0.1791
VAR	0.7500	0.4000	0.0311	-0.0127
DECD	0.4000	1.1000	-0.0537	-0.3628
LINK	0.2500	1.2000	-0.0380	-0.1647
EEC	0.2500	1.2000	-0.0180	-0.2990
DRI	0.4500	2.1000	-0.0089	-0.5577
MCKIBB	0.0750	0.9000	0.0167	-0.5540
MINIMOD	0.2500	1.0000	0.0179	-0.2172
WHARTON	0.1750	1.4000	-0.0331	-0.3993

Source: Brookings simulation results.

Monetary multipliers from simulation D, divided by 4 to go with second-year changes in the level of M; fiscal multipliers from simulation B, with sign reversed to go with fiscal expansion; effects on current account divided by baseline GNP to get effect as a proportion of GNP.

of welfare weights and constant terms as to the choice of policy multipliers. Oudiz and Sachs made their choices based on the calculation of what the welfare weights would have to have been for policy-makers, optimizing in Nash equilibrium, to produce the values of output, inflation and trade balance actually observed in the 1980s. There are problems with this methodology. To use it in our context would require the computation of different weights, not only for the two policy-makers, but for every possible combination of models. Instead we simply take weights from the EPA case of Oudiz and Sachs and apply them uniformly to all models, so as to have a common standard of evaluation.[15] The relative weight on the current account is 0.47, and on output is 0.07.

One point regarding the constant terms can easily escape notice. In assuming that the policy makers react directly to each other's policy-settings g and m rather than to the target variables y and x, we have implicitly assumed that they ignore observed deviations of y and x from what they would have expected based on their models, or treat them as purely random disturbances.[16] An alternative would be to assume that they treat such observed discrepancies as following a random walk, that is, as permanent revisions in the constant terms A and B. This would be equivalent to a perpetual updating of the intercepts of the reaction functions to insure that they always pass through the target optimum $y = x = 0$.

---

[15]We do not use their weights for the MCM case because the reported weight on the U.S. current account is zero.

[16]A complete Bayesian analysis would have agents ascribe only part of the observed discrepancy to the error terms, and part to a revision of the parameter values. But the premise of this paper is that it is realistic to assume that policy-makers revise their models to a negligible extent.

Table 2 reports the results for the Nash equilibrium when the two goals are output and the current account balance, under 36 possible combinations of models to which the monetary and fiscal authorities can subscribe. If one chooses, one can think of the policymakers taking turns in real time. The first entry in each cell reports whether the Nash equilibrium is stable, and the second reports the number of iterations required to reach convergence (of both target variables, to within a tolerance of 1.0 percent).[17] However one may choose instead to think of the policymakers instantly jumping to the Nash equilibrium. The third and fourth entries in each cell give the equilibrium values for the money supply and government expenditure, expressed relative to the baseline used in the simulations. The other entries give the values of the target variables and the welfare funtion that would follow under each of the two models in question.

The main focus of interest is Table 3, which shows the coordination that the two policy makers will view it as in their interest to undertake, under each combination of models. The first two entries in each cell indicate the change, relative to the Nash equilibrium, which they can agree to make in the money supply and government expenditure, respectively, in order to maximize the product of the two perceived gains in welfare. The next two lines indicate the effects that the two agents perceive such a package of policy changes will have on the target

---

[17] Only 12/36 combinations exhibit technical instability (most of them models in which the monetary authority is acting on the basis of either the MCM of VAR models). Another 5/36, though technically stable, require more than 20 iterations to converge.

Table 2: NONCOOPERATIVE NASH EQUILIBRIUM

MODEL SUBSCRIBED TO BY FISCAL AUTHORITY	MODEL SUBSCRIBED TO BY CENTRAL BANK					
	MCM	EPA	LIVPOOL	VAR	OECD	LINK
MCM						
NASH POINT: STABLE?	YES	YES	YES	YES	YES	YES
STEPS	99	99	8	3	4	5
NASH CHANGE IN POLICY						
M	56.44	827.02	-115.34	7.56	2.46	-1.22
G	-9.00	-136.06	19.33	-0.94	-0.10	0.51
PERCEIVED CHANGE IN TARGETS						
CB: Y	4.97	18.22	9.43	5.67	1.84	1.38
CA	2.68	62.32	5.92	0.24	-0.42	-0.19
FA: Y	4.97	65.22	-8.46	1.15	0.75	0.46
CA	2.68	41.00	-5.87	0.25	-0.01	-0.19
PERCEIVED GAIN FOR:						
CB	0.7275	-226.2441	2.2383	0.3251	-0.0328	0.0331
FA	0.7275	-134.1217	-5.9732	0.1852	0.0660	-0.0273
EPA						
NASH POINT: STABLE?	YES	YES	YES	YES	YES	YES
STEPS	15	19	6	3	5	9
NASH CHANGE IN POLICY						
M	53.41	70.84	-87.25	8.77	14.66	26.05
G	-7.56	-9.58	8.68	-2.41	-3.09	-4.41
PERCEIVED CHANGE IN TARGETS						
CB: Y	4.90	4.97	3.24	5.65	2.51	1.29
CA	2.49	4.29	5.64	0.30	0.32	-0.27
FA: Y	3.16	4.97	-11.43	-1.47	-0.86	0.2[illegible]
CA	3.41	4.29	-3.65	1.17	1.47	2.04
PERCEIVED GAIN FOR:						
CB	0.7251	1.4811	2.4094	0.3475	0.3111	-0.0151
FA	1.3970	1.4811	-5.4355	0.4151	0.6076	0.9260
LIVPOOL						
NASH POINT: STABLE?	NO	NO	YES	YES	YES	YES
STEPS	99	99	11	4	12	99
NASH CHANGE IN POLICY						
M	-2592.02	-276.47	-95.12	12.54	75.41	731.08
G	511.19	48.49	12.25	-9.27	-21.83	-152.85
PERCEIVED CHANGE IN TARGETS						
CB: Y	-54.01	-1.12	4.97	5.59	5.81	-1.00
CA	-163.74	-22.36	5.72	0.51	3.99	-2.53
FA: Y	241.91	22.18	4.97	-5.25	-11.21	-73.43
CA	124.00	14.31	5.72	0.62	-2.36	-33.42
PERCEIVED GAIN FOR:						
CB	-1892.2482	-46.5560	2.4398	0.4137	0.8096	-1.6697
FA	-1497.7557	-5.4740	2.4398	-0.3490	-4.5577	-161.8109

Table 2 (continued)

VAR						
NASH POINT: STABLE?	NO	NO	NO	YES	NO	NO
STEPS	99	99	99	99	99	99
NASH CHANGE IN POLICY						
M	4.79	5.13	26.33	52.95	6.07	5.94
G	2.05	1.42	-37.71	-86.86	-0.31	-0.08
PERCEIVED CHANGE IN TARGETS						
CB: Y	3.82	3.82	-21.81	4.97	2.04	1.36
CA	-0.57	-0.75	4.52	2.75	-0.20	-0.21
FA: Y	4.41	4.42	4.66	4.97	4.43	4.43
CA	0.12	0.14	1.30	2.75	0.19	0.19
PERCEIVED GAIN FOR:						
CB	0.0078	-0.2385	-4.8265	0.7528	0.0773	0.0205
FA	0.2882	0.2946	0.6108	0.7528	0.3124	0.3101
OECD						
NASH POINT: STABLE?	NO	NO	YES	YES	YES	NO
STEPS	99	99	14	4	99	99
NASH CHANGE IN POLICY						
M	-50.69	-29.85	-190.71	9.36	60.01	-33.72
G	12.87	7.19	51.04	-3.50	-17.30	8.25
PERCEIVED CHANGE IN TARGETS						
CB: Y	2.58	3.21	26.05	5.64	4.97	1.49
CA	-4.06	-3.44	6.66	0.33	3.06	-0.08
FA: Y	-6.12	-4.03	-20.14	-0.10	4.97	-4.42
CA	-1.95	-1.01	-8.29	0.77	3.06	-1.18
PERCEIVED GAIN FOR:						
CB	-2.3696	-2.5562	-2.0622	0.3583	0.8746	0.0890
FA	-2.0379	-1.0444	-14.0644	0.2649	0.8746	-1.2135
LINK						
NASH POINT: STABLE?	NO	NO	YES	YES	YES	YES
STEPS	99	99	9	3	5	99
NASH CHANGE IN POLICY						
M	-104.61	-18.95	-143.05	7.65	1.63	-1101.93
G	23.46	5.40	31.56	-0.21	1.06	233.71
PERCEIVED CHANGE IN TARGETS						
CB: Y	1.38	3.40	15.54	5.67	1.80	4.97
CA	-7.44	-2.60	6.19	0.24	-0.47	3.34
FA: Y	2.00	1.74	2.11	1.66	1.68	4.97
CA	0.11	-0.17	0.23	-0.26	-0.24	3.34
PERCEIVED GAIN FOR:						
CB	-6.2719	-1.7294	1.3078	0.3267	-0.0592	0.9933
FA	0.2059	0.0648	0.2654	0.0186	0.0292	0.9933

* 99 INDICATES MORE THAN 20 STEPS REQUIRED FOR CONVERGENCE

Table 3: The Movement from the Non-cooperative Solution to the Cooperative Solution

NASH EQUILIBRIUM AND COORDINATION

MODEL SUBSCRIBED TO BY FISCAL AUTHORITY	MODEL SUBSCRIBED TO BY CENTRAL BANK					
	MCM	EPA	LIVPOOL	VAR	OECD	LINK
MCM						
BARGAINING CHANGE IN POLICY						
M	0.00	-765.71	30.23	1.16	35.39	0.33
G	0.00	126.45	-8.13	-0.74	-7.80	0.15
PERCEIVED CHANGE IN TARGETS						
CB: Y	0.00	-14.75	-4.12	0.57	5.57	0.26
CA	0.00	-58.35	-1.06	0.05	0.93	-0.04
FA: Y	0.00	-59.54	-3.30	-0.90	-0.78	0.39
CA	0.00	-38.16	2.83	0.29	2.59	-0.07
PERCEIVED GAIN FOR:						
CB	0.0000	2.2770	0.0015	0.0000	0.0041	0.0000
FA	0.0000	1.3484	0.0171	0.0001	0.0041	0.0001
EPA						
BARGAINING CHANGE IN POLICY						
M	4.01	0.00	2.00	1.22	23.71	0.34
G	-0.73	0.00	0.81	-0.83	-5.01	0.15
PERCEIVED CHANGE IN TARGETS						
CB: Y	0.18	0.00	0.54	0.58	3.97	0.27
CA	0.23	0.00	-0.31	0.05	0.55	-0.04
FA: Y	-0.05	0.00	1.99	-1.05	-1.41	0.36
CA	0.34	0.00	-0.45	0.42	2.38	-0.08
PERCEIVED GAIN FOR:						
CB	0.0000	0.0000	0.0001	0.0000	0.0022	0.0000
FA	0.0003	0.0000	0.0012	0.0002	0.0034	0.0001
LIVPOOL						
BARGAINING CHANGE IN POLICY						
M	2558.50	209.76	0.00	-0.43	-20.80	-1017.32
G	-505.17	-41.86	0.00	-1.03	6.29	214.84
PERCEIVED CHANGE IN TARGETS						
CB: Y	50.14	-8.24	0.00	-0.74	-1.40	3.47
CA	162.36	19.77	0.00	-0.00	-1.17	3.23
FA: Y	-239.14	-19.87	0.00	-0.63	3.25	103.47
CA	-122.29	-9.95	0.00	0.22	0.60	46.12
PERCEIVED GAIN FOR:						
CB	18.9109	0.4280	0.0000	0.0000	0.0006	0.0214
FA	14.9907	0.0772	0.0000	0.0002	0.0158	1.5469
VAR						
BARGAINING CHANGE IN POLICY						
M	3.85	4.78	0.70	0.00	5.14	0.30
G	-2.89	-5.10	0.45	0.00	-4.90	0.19
PERCEIVED CHANGE IN TARGETS						
CB: Y	-3.76	-7.24	0.29	0.00	-3.34	0.30
CA	1.14	2.62	-0.14	0.00	1.50	-0.04
FA: Y	1.73	1.54	0.70	0.00	1.89	0.30
CA	0.16	0.21	0.02	0.00	0.22	0.01
PERCEIVED GAIN FOR:						
CB	0.0018	0.0062	0.0013	0.0000	0.0020	0.0000
FA	0.0004	0.0006	0.0000	0.0000	0.0006	0.0000

Table 3 (continued)

OECD						
BARGAINING CHANGE IN POLICY						
M	88.31	67.99	140.74	1.94	0.00	0.31
G	-20.08	-15.67	-42.80	-1.58	0.00	0.17
PERCEIVED CHANGE IN TARGETS						
CB: Y	-3.03	-6.24	-22.16	0.82	0.00	0.28
CA	6.72	7.51	-4.04	0.08	0.00	-0.04
FA: Y	13.23	9.96	9.21	-0.97	0.00	0.31
CA	2.55	2.04	7.98	0.47	0.00	-0.08
PERCEIVED GAIN FOR:						
CB	0.0280	0.0339	0.0385	0.0001	0.0000	0.0000
FA	0.0246	0.0163	0.1165	0.0002	0.0000	0.0001
LINK						
BARGAINING CHANGE IN POLICY						
M	-0.66	-0.72	-0.64	0.00	-0.74	0.00
G	-0.08	-0.09	-0.08	0.00	-0.06	0.00
PERCEIVED CHANGE IN TARGETS						
CB: Y	-0.40	-0.37	-0.06	0.00	-0.36	0.00
CA	0.05	0.06	0.07	0.00	0.06	0.00
FA: Y	-0.27	-0.29	-0.26	0.00	-0.26	0.00
CA	0.04	0.04	0.04	0.00	0.04	0.00
PERCEIVED GAIN FOR:						
CB	0.0004	0.0004	0.0001	0.0000	0.0000	0.0000
FA	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

* 99 INDICATES MORE THAN 20 STEPS REQUIRED FOR CONVERGENCE

Table 4: TRUE GAINS FROM COORDINATION

MODEL SUBSCRIBED TO BY FISCAL AUTHORITY	MODEL SUBSCRIBED TO BY CENTRAL BANK					
	MCM	EPA	LIVPOOL	VAR	OECD	LINK
MCM						
MODEL REPRESENTING REALITY:						
MCM	0.0000	1.3484	0.0171	0.0001	0.0041	0.0001
EPA	0.0000	2.2770	0.0546	0.0015	0.0119	-0.0003
LIVPOOL	0.0000	2.0602	0.0015	-0.0001	-0.0190	-0.0004
VAR	0.0000	31.7657	0.2946	0.0000	-0.0384	0.0003
OECD	0.0000	3.1227	0.0235	0.0008	0.0041	-0.0001
LINK	0.0000	0.2490	-0.0041	-0.0000	-0.0007	0.0000
EPA						
MODEL REPRESENTING REALITY:						
MCM	0.0000	0.0000	0.0077	-0.0011	0.0009	0.0003
EPA	0.0003	0.0000	0.0012	0.0002	0.0034	0.0001
LIVPOOL	-0.0030	0.0000	0.0001	-0.0002	-0.0137	-0.0004
VAR	-0.0180	0.0000	0.0245	0.0000	-0.0381	-0.0008
OECD	-0.0011	0.0000	0.0091	0.0004	0.0022	-0.0003
LINK	-0.0002	0.0000	0.0042	-0.0004	-0.0004	0.0000
LIVPOOL						
MODEL REPRESENTING REALITY:						
MCM	18.9109	0.2028	0.0000	-0.0091	0.0248	1.1951
EPA	41.0267	0.4280	0.0000	-0.0076	0.0366	2.5755
LIVPOOL	14.9907	0.0772	0.0000	0.0002	0.0158	1.5469
VAR	309.6838	3.5307	0.0000	0.0000	0.0943	19.6584
OECD	24.6334	0.3501	0.0000	-0.0029	0.0006	1.1925
LINK	0.2288	0.0048	0.0000	-0.0032	0.0045	0.0214
VAR						
MODEL REPRESENTING REALITY:						
MCM	0.0018	-0.0032	0.0172	0.0000	-0.0081	0.0001
EPA	0.0076	0.0062	0.0167	0.0000	-0.0001	-0.0003
LIVPOOL	0.0003	0.0012	0.0013	0.0000	0.0001	-0.0004
VAR	0.0004	0.0006	0.0000	0.0000	0.0006	0.0000
OECD	0.0035	0.0041	0.0079	0.0000	0.0020	-0.0002
LINK	0.0003	-0.0014	0.0064	0.0000	-0.0030	0.0000
OECD						
MODEL REPRESENTING REALITY:						
MCM	0.0280	0.0116	0.2626	-0.0038	0.0000	-0.0002
EPA	0.0699	0.0339	0.5784	-0.0016	0.0000	-0.0009
LIVPOOL	-0.0352	-0.0307	0.0385	-0.0003	0.0000	-0.0003
VAR	0.1135	0.0269	1.5194	0.0001	0.0000	0.0017
OECD	0.0246	0.0163	0.1165	0.0002	0.0000	0.0001
LINK	-0.0015	-0.0017	0.0101	-0.0014	0.0000	0.0000
LINK						
MODEL REPRESENTING REALITY:						
MCM	0.0004	-0.0001	0.0005	0.0000	-0.0002	0.0000
EPA	0.0013	0.0004	0.0016	0.0000	0.0001	0.0000
LIVPOOL	0.0002	0.0005	0.0001	0.0000	0.0005	0.0000
VAR	-0.0081	-0.0021	-0.0104	0.0000	-0.0005	0.0000
OECD	-0.0010	-0.0001	-0.0013	0.0000	0.0000	0.0000
LINK	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

variables; they can be obtained by taking the product of the change in policy settings and the multipliers reported in Table 1. The last two lines in each cell indicate how much the central bank and fiscal authority, respectively, thinks that the country has to gain in terms of the welfare function (equation (3)) by the movement of the policy-settings in the indicated direction. If the policy makers happen to believe the same model (the diagonal cells), then there is no scope for coordination. This is a consequence of our ruling out conflicting welfare functions; each thinks that the country is at the optimum.

Otherwise, there will be scope for coordination. Consider the example where the central bank subscribes to the MCM model and the fiscal authority to the OECD model. Each perceives that they can accomplish relatively large welfare gains by an alteration of the mix in favor of more expansionary monetary policy and more restrictive government spending. This is the kind of coordination that has been suggested frequently for the United States in the 1980s; the Nash non-cooperative solution consists of monetary policy that is too tight and fiscal policy that is too loose, resulting in too high a level of interest rates, value of the dollar, and size of the trade deficit. It shows up in 15 cases in Table 3. But all other combinations appear as well. Coordination could call for contractionary monetary policy and expansionary fiscal policy (3 cases, 2 of them cases where the fiscal authority subscribes to the Liverpool model), or expansion on both fronts (6 cases, all of them cases where the monetary authority subscribes to the Liverpool or LINK models), or contraction on both fronts (5 cases, most of them cases where the fiscal authority subscribes to the LINK model).

To find out whether a given plan for policy coordination raises welfare in truth, rather than only in the perceptions of the policy makers, we would have to know the true model. This we cannot do. But we can get an idea of the range of possibilities by judging it by the standard of each of the other models in the Brookings simulations. The 36 cells in Table 4 correspond to the same 6 x 6 combinations of subscribed-to models as in Table 3. Each gives the true welfare gains, under 6 possible models of reality.

Consider again the example where the central bank subscribes to the MCM and the fiscal authority to the OECD model. If either the MCM or OECD models coincides with the true model, then there will necessarily be a true welfare gain, equal to .0280 or .0246, respectively, just as the central bank or fiscal authority, respectively, thought there would be. (Take the square roots to get welfare units expressed in terms of percentage points of output.) It turns out that if the true model happens to be the EPA or VAR model, then there will also be a welfare gain. But if the true model is the Liverpool or LINK model, then there will be a welfare loss. The coordination plan moves policy settings in the wrong direction, and everyone would have been better off staying with the Nash competitive equilibrium. One can see why by consulting Tables 5-8, which give the actual effects on the target variables. The reason the central bank and fiscal authority agreed to the change in the policy mix, when the former believed the MCM and latter the OECD model, is that both thought it would improve the current account. But we see in Table 8 that such a change, according the the Liverpool of LINK models, in fact <u>worsens</u> the current account. This

Table 5: TRUE DEVIATION OF Y FROM TARGET FOR US

MODEL SUBSCRIBED TO BY FISCAL AUTHORITY	MODEL SUBSCRIBED TO BY CENTRAL BANK					
	MCM	EPA	LIVPOOL	VAR	OECD	LINK
MCM						
MODEL REPRESENTING REALITY:						
MCM	0.0000	0.7128	-16.7317	-4.7164	-4.9969	-4.1153
EPA	-1.9079	-1.4990	-10.0432	-3.7777	-5.6204	-2.6894
LIVPOOL	-8.2416	-8.4920	0.3354	-5.0423	-8.0487	-3.8808
VAR	34.1267	37.5387	-63.9532	1.2696	20.6262	-5.0050
OECD	8.6729	9.9423	-25.7322	-2.3604	2.4443	-3.6351
LINK	-0.5815	-0.1063	-11.7360	-3.7257	-3.9127	-3.3250
EPA						
MODEL REPRESENTING REALITY:						
MCM	0.1146	2.8462	-21.3645	-8.5678	-6.6785	-4.2402
EPA	-1.8529	0.0000	-14.4107	-7.4841	-7.2366	-4.2853
LIVPOOL	-8.3017	-8.7332	-1.1943	-6.4534	-8.6608	-6.6509
VAR	34.8074	44.3613	-65.0792	1.2619	20.5965	13.1571
OECD	8.9109	12.8728	-28.5881	-4.4966	1.5048	0.9497
LINK	-0.5051	1.3159	-14.8245	-6.2933	-5.0338	-3.4083
LIVPOOL						
MODEL REPRESENTING REALITY:						
MCM	-8.8435	-20.2104	-20.7404	-21.1082	-14.6059	-2.8765
EPA	-5.3873	-14.3254	-13.2871	-19.4424	-15.6035	13.9371
LIVPOOL	-2.1934	-2.6645	-0.0000	-10.8451	-12.9277	25.0673
VAR	-27.8120	-52.4570	-71.5160	-0.1141	29.6644	-194.9638
OECD	-12.0996	-24.7141	-29.8917	-11.7987	-0.5646	-51.6255
LINK	-6.4772	-14.0551	-14.4085	-14.6536	-10.3187	-2.4991
VAR						
MODEL REPRESENTING REALITY:						
MCM	-4.9133	-9.5370	-63.5687	-143.1262	-11.8082	-4.0977
EPA	-3.9595	-8.3949	-60.3521	-136.8941	-10.6102	-3.0590
LIVPOOL	-5.1002	-6.7680	-26.4905	-55.6022	-7.6548	-4.5880
VAR	1.1738	0.9901	0.3962	0.0000	1.3504	-0.2471
OECD	-2.4940	-5.1034	-35.1982	-79.3878	-6.2697	-2.4062
LINK	-3.8570	-6.9395	-42.9606	-95.9990	-8.4536	-3.3133
OECD						
MODEL REPRESENTING REALITY:						
MCM	-5.4155	-7.5070	-10.4543	-11.4562	-15.1923	-3.9277
EPA	-6.0030	-8.0072	-6.0178	-10.2830	-16.4499	-0.7507
LIVPOOL	-8.1646	-8.9151	-1.0859	-7.5471	-13.6635	-0.5662
VAR	20.3758	20.2664	-39.1329	1.4925	33.1360	-26.6433
OECD	2.1482	0.9611	-15.8933	-6.0382	0.0000	-9.0760
LINK	-4.1918	-5.5862	-7.5510	-8.2190	-10.7097	-3.2000
LINK						
MODEL REPRESENTING REALITY:						
MCM	-3.9851	-4.4057	-3.7985	-4.0885	-4.4494	0.8722
EPA	3.0879	-1.9465	5.3447	-3.1268	-3.1016	61.6607
LIVPOOL	6.6012	-2.0996	10.5046	-4.7261	-4.1706	107.8856
VAR	-74.5666	-17.5891	-100.1328	0.6962	-3.8895	-737.9225
OECD	-21.3881	-7.0207	-27.8361	-2.1593	-3.5344	-188.6813
LINK	-3.2382	-3.5106	-3.1138	-3.3071	-3.5478	0.0000

Table 6: TRUE DEVIATION OF CA FROM TARGET FOR US

MODEL SUBSCRIBED TO BY FISCAL AUTHORITY	MODEL SUBSCRIBED TO BY CENTRAL BANK					
	MCM	EPA	LIVPOOL	VAR	OECD	LINK
MCM						
MODEL REPRESENTING REALITY:						
MCM	0.0000	0.1651	-5.7120	-2.1420	-0.0940	-2.9369
EPA	-0.5957	-0.3207	-9.7174	-3.9392	-0.9795	-5.0637
LIVPOOL	-9.0121	-9.3068	-0.8578	-6.3553	-7.6628	-5.9744
VAR	-0.8906	-0.7312	-5.5423	-2.4652	-1.4817	-2.7933
OECD	-3.1406	-3.1773	-2.8723	-3.2364	-2.5410	-3.5683
LINK	-4.1431	-4.2261	-2.0962	-3.5376	-3.6181	-3.5576
EPA						
MODEL REPRESENTING REALITY:						
MCM	0.0400	0.3133	-4.6365	-1.1530	0.3351	-1.0509
EPA	-0.5319	-0.0000	-8.3848	-2.6938	-0.4396	-2.3314
LIVPOOL	-9.0686	-9.9557	-0.3901	-6.0303	-7.5191	-7.2129
VAR	-0.8583	-0.4253	-5.5146	-2.3952	-1.4524	-1.8730
OECD	-3.1422	-3.3984	-1.9416	-2.4322	-2.1908	-2.9448
LINK	-4.1572	-4.4560	-1.6718	-3.1899	-3.4662	-3.6456
LIVPOOL						
MODEL REPRESENTING REALITY:						
MCM	-4.0499	-3.6446	-5.4539	1.9291	3.2979	-22.6456
EPA	-6.9138	-6.8876	-9.5409	1.1611	3.4702	-33.6198
LIVPOOL	-4.0077	-1.3554	-0.0000	-4.8794	-7.4750	6.98[illegible]
VAR	-3.8597	-4.8977	-5.8513	-2.2356	-0.8492	-12.[illegible]
OECD	-3.3310	-1.7675	-2.2837	0.1419	-0.2367	-10.[illegible]
LINK	-3.0060	-1.8450	-1.6929	-2.0502	-2.8000	-2.6304
VAR						
MODEL REPRESENTING REALITY:						
MCM	-2.1011	-0.9317	12.8925	33.2964	-0.3113	-2.4558
EPA	-3.8897	-2.4204	14.9796	40.6707	-1.6319	-4.3642
LIVPOOL	-6.3321	-5.9300	-1.3380	5.3905	-5.7635	-6.3031
VAR	-2.4664	-2.3912	-1.4338	-0.0000	-2.3315	-2.5532
OECD	-3.1984	-2.2387	9.0274	25.6317	-1.7524	-3.4155
LINK	-3.5193	-3.1009	1.7804	8.9652	-2.8978	-3.5852
OECD						
MODEL REPRESENTING REALITY:						
MCM	-0.0120	0.5143	-4.7916	-0.3872	3.8029	-5.1939
EPA	-0.8811	-0.2203	-8.0704	-1.7247	4.1746	-8.3316
LIVPOOL	-7.6103	-7.4266	-3.0934	-5.8029	-7.6643	-4.5021
VAR	-1.4867	-1.4540	-4.4025	-2.3308	-0.6631	-3.8905
OECD	-2.4618	-2.0286	-3.3669	-1.8213	-0.0000	-4.3193
LINK	-3.5790	-3.3895	-2.7986	-2.9303	-2.7661	-3.4562
LINK						
MODEL REPRESENTING REALITY:						
MCM	-10.0710	-4.1468	-12.7286	-2.3618	-2.7372	-79.0324
EPA	-15.4161	-6.8349	-19.2659	-4.2274	-4.7903	-115.3088
LIVPOOL	-1.2015	-5.0845	0.5410	-6.3687	-6.0229	44.0089
VAR	-6.3117	-3.4241	-7.6074	-2.5056	-2.7308	-39.9298
OECD	-5.8838	-3.9216	-6.7638	-3.3864	-3.4618	-28.7198
LINK	-3.1889	-3.4625	-3.0660	-3.5912	-3.5335	0.0000

Table 7: BARGAINING DEVIATION OF Y FROM NASH FOR US

MODEL SUBSCRIBED TO BY FISCAL AUTHORITY	MODEL SUBSCRIBED TO/BY CENTRAL BANK					
	MCM	EPA	LIVPOOL	VAR	OECD	LINK
MCM						
MODEL REPRESENTING REALITY:						
MCM	0.0000	-59.5359	-3.3015	-0.8955	-0.7769	0.3922
EPA	0.0000	-14.7524	-4.7557	-0.9084	-2.6506	0.3527
LIVPOOL	0.0000	56.7256	-4.1237	-0.4141	-3.7979	0.0981
VAR	0.0000	-523.7030	19.4213	0.5721	23.4202	0.3050
OECD	0.0000	-167.1917	3.1471	-0.3496	5.5709	0.2955
LINK	0.0000	-39.6906	-2.2010	-0.5970	-0.5179	0.2615
EPA						
MODEL REPRESENTING REALITY:						
MCM	0.1820	0.0000	2.2172	-1.0387	-0.1331	0.4006
EPA	-0.0453	0.0000	1.9856	-1.0471	-1.4099	0.3598
LIVPOOL	-0.3402	0.0000	0.5388	-0.4683	-2.4152	0.0992
VAR	2.7129	0.0000	1.8277	0.5829	15.7758	0.3179
OECD	0.7960	0.0000	1.6971	-0.4262	3.9688	0.3035
LINK	0.1213	0.0000	1.4782	-0.6925	-0.0887	0.2671
LIVPOOL						
MODEL REPRESENTING REALITY:						
MCM	50.1388	3.3076	0.0000	-2.0165	3.5228	5.2102
EPA	-91.2320	-8.2383	0.0000	-1.8812	4.4540	60.0257
LIVPOOL	-239.1370	-19.8738	0.0000	-0.6291	3.2547	103.4688
VAR	1716.8079	140.5773	0.0000	-0.7352	-13.0870	-677.0562
OECD	467.7173	37.8559	0.0000	-1.3059	-1.4013	-170.6083
LINK	33.4259	2.2051	0.0000	-1.3444	2.3485	3.4735
VAR						
MODEL REPRESENTING REALITY:						
MCM	-3.7632	-7.3951	1.0681	0.0000	-6.9008	0.4449
EPA	-3.7628	-7.2433	0.9708	0.0000	-6.7959	0.4040
LIVPOOL	-1.6396	-2.9431	0.2859	0.0000	-2.8143	0.1185
VAR	1.7315	1.5439	0.7045	0.0000	1.8933	0.2973
OECD	-1.6417	-3.7025	0.7724	0.0000	-3.3390	0.3227
LINK	-2.5088	-4.9301	0.7120	0.0000	-4.6005	0.2966
OECD						
MODEL REPRESENTING REALITY:						
MCM	-3.0297	-2.7101	-24.2659	-2.1235	0.0000	0.4210
EPA	-7.6446	-6.2426	-30.5411	-2.1107	0.0000	0.3807
LIVPOOL	-9.8404	-7.7028	-22.1624	-0.9020	0.0000	0.1091
VAR	58.1969	44.7276	88.4326	0.8226	0.0000	0.3019
OECD	13.2340	9.9596	9.2135	-0.9660	0.0000	0.3106
LINK	-2.0198	-1.8067	-16.1773	-1.4157	0.0000	0.2806
LINK						
MODEL REPRESENTING REALITY:						
MCM	-0.3985	-0.4362	-0.3838	0.0000	-0.3879	0.0000
EPA	-0.3403	-0.3728	-0.3278	0.0000	-0.3265	0.0000
LIVPOOL	-0.0663	-0.0732	-0.0640	0.0000	-0.0557	0.0000
VAR	-0.5318	-0.5782	-0.5114	0.0000	-0.5767	0.0000
OECD	-0.3571	-0.3899	-0.3437	0.0000	-0.3627	0.0000
LINK	-0.2656	-0.2908	-0.2558	0.0000	-0.2586	0.0000

Table 8: BARGAINING DEVIATION OF CA FROM NASH FOR US

MODEL SUBSCRIBED TO BY FISCAL AUTHORITY	MODEL SUBSCRIBED TO BY CENTRAL BANK					
	MCM	EPA	LIVPOOL	VAR	OECD	LINK
MCM						
MODEL REPRESENTING REALITY:						
MCM	0.0000	-38.1586	2.8309	0.2885	2.5903	-0.0697
EPA	0.0000	-58.3521	3.9471	0.3746	3.7227	-0.0817
LIVPOOL	0.0000	41.0303	-1.0575	0.0361	-1.5452	-0.0540
VAR	0.0000	-25.3826	1.0420	0.0453	1.1980	0.0082
OECD	0.0000	-4.7922	1.3285	0.2059	0.9327	-0.0719
LINK	0.0000	8.2388	0.1919	0.0777	-0.0579	-0.0371
EPA						
MODEL REPRESENTING REALITY:						
MCM	0.2302	0.0000	-0.3832	0.3264	1.6446	-0.0705
EPA	0.3432	0.0000	-0.4467	0.4226	2.3813	-0.0825
LIVPOOL	-0.2019	0.0000	-0.3125	0.0474	-1.0737	-0.0556
VAR	0.1338	0.0000	0.0519	0.0484	0.7998	0.0087
OECD	0.0512	0.0000	-0.4030	0.2361	0.5468	-0.0732
LINK	-0.0313	0.0000	-0.2102	0.0906	-0.0742	-0.0379
LIVPOOL						
MODEL REPRESENTING REALITY:						
MCM	162.3616	13.4997	0.0000	0.4432	-2.2411	-70.4505
EPA	238.2319	19.7654	0.0000	0.5437	-3.0799	-102.0375
LIVPOOL	-122.2898	-9.9462	0.0000	0.2204	0.6033	46.1229
VAR	85.8599	7.0450	0.0000	-0.0003	-0.7259	-34.3171
OECD	46.0028	3.9335	0.0000	0.3970	-1.1663	-23.3604
LINK	-13.9147	-1.0673	0.0000	0.1861	-0.2465	3.2320
VAR						
MODEL REPRESENTING REALITY:						
MCM	1.1438	2.0580	-0.2026	0.0000	1.9666	-0.0840
EPA	1.4746	2.6224	-0.2413	0.0000	2.5142	-0.0999
LIVPOOL	0.1979	0.5167	-0.1384	0.0000	0.4511	-0.0579
VAR	0.1563	0.2132	0.0161	0.0000	0.2218	0.0069
OECD	0.8430	1.5954	-0.1999	0.0000	1.5037	-0.0831
LINK	0.3303	0.6592	-0.1003	0.0000	0.6127	-0.0418
OECD						
MODEL REPRESENTING REALITY:						
MCM	6.7191	5.2621	15.2626	0.6297	0.0000	-0.0774
EPA	9.6064	7.5065	20.9612	0.8092	0.0000	-0.0915
LIVPOOL	-3.7471	-2.8477	-4.0377	0.1223	0.0000	-0.0562
VAR	2.9969	2.3103	4.9133	0.0804	0.0000	0.0076
OECD	2.5472	2.0374	7.9775	0.4706	0.0000	-0.0780
LINK	-0.0447	0.0001	1.7072	0.1872	0.0000	-0.0397
LINK						
MODEL REPRESENTING REALITY:						
MCM	0.0481	0.0531	0.0464	0.0000	0.0408	0.0000
EPA	0.0501	0.0555	0.0484	0.0000	0.0401	0.0000
LIVPOOL	0.0701	0.0765	0.0675	0.0000	0.0723	0.0000
VAR	-0.0196	-0.0213	-0.0188	0.0000	-0.0221	0.0000
OECD	0.0657	0.0721	0.0633	0.0000	0.0620	0.0000
LINK	0.0389	0.0425	0.0374	0.0000	0.0382	0.0000

conclusion is probably less alarming for those who are not fans of either of these two models, than for those who are. But such readers should recognize the possibility that the fiscal authority will subscribe to, say, the Liverpool model and the central bank to the VAR model; then the coordination plan (monetary and fiscal contraction) will again worsen welfare as judged by the other four models.

Of course the proper strategy, if the true model could be discovered, would be simply for both policy makers to optimize subject to it. The point here is that one cannot, under conditions where policy makers subscribe to different models, make the blanket pronouncement that coordination must improve welfare.

Of the 216 (= 6^3) possible combinations in Table 4, 180 (= 216 - 6^3) involve disagreement between the policymakers, and therefore bargaining. Of the 180, welfare is improved by bargaining in 105 cases and worsened in 54 cases. (In 21 cases the effect is not perceptible: zero to four decimal places.) However in 60 (= 2 x 6 x 5) of these cases, one agency or the other has the true model, so that a non-negative welfare change is guaranteed. Of the 120 (= 6 x 5 x 4) cases where the agencies' models differ not only from each other but also from the true model, welfare is perceptibly improved in 61 and worsened in 54.

When all 11 available models are used (the Taylor model reports no results for the current account) there are 1331 (= 11^3) possible combinations. Of the 1210 (= 1331 - 11^2) that involve disagreement and bargaining, welfare is perceptibly improved in 728 cases and worsened in 390 cases. Of the 990 (= 11 x 10 x 9) cases where three distinct models are involved, welfare is perceptibly improved in 556 cases and worsened in 390 cases. As a sensitivity analysis with respect to targets, we tried redoing the analysis with a target level of GNP assumed to be 25 percent above the baseline. When all 11 models are used, 559 of the cases involving 3 distinct models show perceptible welfare gains from bargaining and 291 show losses. We also tried a target level of GNP assumed to be 5 percent below the baseline; 512 of the cases involving 3 distinct models show welfare gains and 280 show losses.[18] It may not be a coincidence that coordination does, after all, produce welfare gains in a majority of cases. A convex combination of two sets of parameter estimates—even such a strange nonlinear "convex combination" as comes out of the coordination mathematics—may be closer to the true answer, and on average closer to any third set of parameter estimates, than either individually. But to the extent there are possible gains from coordination of this type, it might be more advantageous for the agencies to realize them by bargaining over the correct model rather than over the policies.

4. Extensions

Quite a number of extensions have been left for future research, even after the same issues that have been investigated here for domestic policy making are repeated for international policy making. We could try different objective functions. For the exercises where the policy makers are viewed as taking turns in real time, we could use the more complete time profile of multiplier effects reported in the Brookings simulation. We could compare the results of two possible kinds of

---

[18] We also tried putting equal weights on the two targets. Of the cases involving 3 distinct models, 461 show gains and 328 show losses.

cooperation among policy makers: the Nash bargaining solution versus maximization of joint welfare based on a model with parameter values determined by averaging the estimates of the two.

More ambitious modeling is possible. We could study the Nash equilibrium in which the policy-maker is uncertain which model is correct, or is uncertain which model the <u>other</u> player believes in. We could study a Stackelberg equilibrium in which the U.S. policy makers are able to choose their preferred point on the other countries' reaction curve. It would be interesting to compare a naive Stackelberg equilibrium in which the U.S. authority assumes that the others' actions are based on the same model as its own, versus, the "rational expectations" Stackelberg equilibrium in which the U.S. authorities realize that the foreign governments will react on the basis of their own model, even though that model is different from the model that the U.S. authorities themselves believe to be correct. Other possibilities include having the policy makers update their parameter estimates each period to reflect new information in a Bayesian manner, evaluating institutional arrangements like fixed exchange rates that might substitute for coordination, and applying game theory concepts of repeated games and precommitment.

References

Bergsten, C.F. et al. Promoting World Recovery: A Statement on Global Economic Strategy by Twenty-six Economists from Fourteen Countries. Washington, D.C.: Institute for International Economics, December 1982.

Canzoneri, Matthew; and Gray, Jo Anna. "Monetary Policy Games and the Consequences of Non-Cooperative Behavior." Federal Reserve Board, Discussion Paper No. 219, February 1983. International Economic Review, forthcoming.

Cooper, Richard. "Economic Interdependence and Coordination of Economic Policies." In Handbook in International Economics, Vol. II. Edited by R. Jones and P. Kenen. Amsterdam: North Holland, 1985.

Frankel, Jeffrey. "The Sources of Disagreement Among International Macromodels and Implications for Policy Coordination." NBER Working Paper No. 1925, May 1986.

Frankel, Jeffrey; and Rockett, Katharine. "International Macroeconomic Policy Coordination When Policy-Makers Disagree About the Model." U.C. Berkeley, June 1986. Revised, Federal Reserve Board, September 1986.

Layard, R.; Basevi, G.; Blanchard, O.; Buiter, W.; and Dornbusch, R. Europe: The Case for Unsustainable Growth. Centre for Economic Policy Studies, Paper No. 819. 1984.

Marris, Stephen. Deficits and the Dollar: The World Economy at Risk. Institute for International Economics, Policy Analyses in International Economics No. 14. (December 1985).

McKibbin, Warwick; and Sachs, Jeffrey. "Coordination of Monetary and Fiscal Policies in the OECD." In International Aspects of Fiscal Policies. Edited by J. Frenkel. Chicago: NBER, University of Chicago Press, forthcoming.

Oudiz, Gilles; and Sachs, Jeffrey. "Macroeconomic Policy Coordination among the Industrial Economies." Brookings Papers on Economic Activity. (1984): 1-76.

Rogoff, Kenneth. "Productive and Counterproductive Cooperative Monetary Policies." Federal Reserve Board, Int. Finance Discussion Paper No. 233, Dec. 1983. QJE (1985).

Sachs, Jeffrey. "The Dollar and the Policy Mix: 1985." Brookings Papers on Economic Activity. (1985): 117-195.

Jan-87

RECENT ISSUES OF THE WORKING PAPER SERIES
OF THE DEPARTMENT OF ECONOMICS
UNIVERSITY OF CALIFORNIA, BERKELEY

Copies may be obtained from the Institute of Business and Economic Research. See the inside cover for further details.

8613 Drew Fudenberg and Jean Tirole
NONCOOPERATIVE GAME THEORY FOR INDUSTRIAL ORGANIZATION: AN INTRODUCTION AND OVERVIEW
Nov-86.

8614 Jeffrey A. Frankel and Kenneth A. Froot
THREE ESSAYS USING SURVEY DATA ON EXCHANGE RATE EXPECTATIONS
Nov-86.

8615 Joseph Farrell
COMMUNICATION BETWEEN POTENTIAL ENTRANTS
Nov-86.

8616 Joseph Farrell and Suzanne Scotchmer
PARTNERSHIPS
Nov-86.

8617 Wan-Jin Kim
ON THE RATE OF CONVERGENCE OF THE CORE
Dec-86.

8618 Joseph Farrell and Nancy T. Gallini
SECOND-SOURCING AS A COMMITMENT: MONOPOLY INCENTIVES TO ATTRACT COMPETITION
Dec-86.

8619 Roger L. Ransom and Richard Sutch
TONTINE INSURANCE AND THE ARMSTRONG INVESTIGATION: A CASE OF STIFLED INNOVATION IN THE AMERICAN LIFE INSURANCE INDUSTRY, 1868-1905
Dec-86.

Jan-87

RECENT ISSUES OF THE WORKING PAPER SERIES
OF THE DEPARTMENT OF ECONOMICS
UNIVERSITY OF CALIFORNIA, BERKELEY

Copies may be obtained from the Institute of Business and Economic Research. See the inside cover for further details.

8620 Joseph Farrell and Robert Gibbons
CHEAP TALK IN BARGAINING GAMES

Dec-86.

8621 Robert M. Anderson
CORE ALLOCATIONS AND SMALL INCOME TRANSFERS

Dec-86.

8722 Joseph Farrell
COMPETITION WITH LOCK-IN

Jan-87.

8723 Pranab Bardhan and Nirvikar Singh
MULTINATIONAL RIVALRY AND NATIONAL ARBITRAGE: SOME THEORETICAL CONSIDERATIONS

Jan-87.

8724 Albert Fishlow
LESSONS OF THE 1890S FOR THE 1980S

Jan-87.

8725 Jeffrey A. Frankel
THE SOURCES OF DISAGREEMENT AMONG INTERNATIONAL MACRO MODELS, AND IMPLICATIONS FOR POLICY COORDINATION
Jan-87.

8726 Jeffrey A. Frankel and James H. Stock
REGRESSION VS. VOLATILITY TESTS OF THE EFFICIENCY OF FOREIGN EXCHANGE MARKETS
Jan-87.