Working Paper

INTERNATIONAL MONETARY FUND

IMF WORKING PAPER

© 1991 International Monetary Fund

This is a working paper and the author would welcome any comments on the present text. Citations should refer to an unpublished manuscript, mentioning the author and the date of issuance by the International Monetary Fund. The views expressed are those of the author and do not necessarily represent those of the Fund.

WP/91/64

INTERNATIONAL MONETARY FUND

Research Department

Portfolio Preference Uncertainty and Gains from Policy Coordination

Prepared by Paul R. Masson *

June 1991

Abstract

International macroeconomic policy coordination is generally considered to be made less likely--and less profitable--by the presence of uncertainty about how the economy works. The present paper provides a counter-example, in which increased uncertainty about portfolio preference of investors makes coordination of monetary policy more beneficial. In particular, in the absence of coordination monetary authorities may respond to financial market uncertainty by not fully accommodating demands for increased liquidity, for fear of bringing about exchange rate depreciation. Coordinated monetary expansion would minimize this danger. A theoretical model incorporating an equity market is developed, and the stock market crash of October 1987 is discussed in the light of its implications for monetary policy coordination.

JEL Classification Numbers:

C73, E44, E52, F31

* The author is grateful to Atish Ghosh and Peter Isard for discussion of the issues, to Claire Adams for expert research assistance, and to Kellett Hannah for supplying Salomon Brothers' measure of implied stock market volatility.

<u>Contents</u>	<u>Page</u>
I. Introduction	1
II. The Model	3
III. Optimal Government Policy	5
IV. The Stock Market Crash of October 1987	7
V. Conclusions	9
Figures	
1. Stock Market Prices, January 1985 to September 1990	8a
2. U.S. Dollar Exchange Rates, January 1985 to December 1990	8b
3. Implied Volatility of S&P 500, January 1, 1987 to October 12, 1990	8c
4. Short-term Interest Rates, January 1985 to December 1990	8d
Appendix Solution of the Model	11
References	15

I. Introduction

There is already a large literature that considers the conditions under which the international coordination of economic policies could be expected to be beneficial. Several factors have been shown to influence the gains, including the "reputation" of governments, i.e. their ability to precommit to fully optimal, but possibly time-inconsistent policies (Currie and others 1987), the size and nature of international spillovers (Cooper 1985, Oudiz and Sachs 1984), the nature of governments' objective functions (Martínez Oliva and Sinn 1988), and so forth. The likelihood that policy coordination will be achieved has also been debated, and skepticism expressed concerning the possibility of agreeing on coordinated policies when there is disagreement concerning how the economy functions, and, in particular, about the effects of policies (Feldstein 1988, Frankel and Rockett 1988). It is natural to treat such disagreement among policymakers in a framework where there is uncertainty about the appropriate model of the world economy, and to relate disagreement about models to uncertainty about key parameters of a general model that nests the various alternative views. 1/ This was the approach of Ghosh and Ghosh (1986) and Ghosh and Masson (1988), in which it was shown that uncertainty about parameter values could increase expected gains from coordination, especially when such uncertainty related to the transmission effects of policies from one country to another.

The present paper attempts to extend the intuition concerning the effects of uncertainty on expected gains from coordination, 2/ by considering the case where policymakers must take account of uncertainty concerning the portfolio preferences of investors. It seems likely that part of the fluctuation observed in asset prices is related not to news concerning fundamentals but rather to shifts in asset preferences; this is one interpretation that can be given to the evidence of variance bound tests, which suggests that the excess volatility of asset prices exceeds that of fundamentals. 3/ A recent example of sudden portfolio shifts is associated with the generalized crash of all major stock markets in October 1987, during which many investors dumped their shares on the market in an attempt to shift out of stocks into other assets at virtually any price.

Moreover, shifts in portfolio preferences that lead to a sudden decline in stock prices are often associated with increased uncertainty, as

1/ However, disagreement over the correct model can exist even when each policymaker is certain that he is right. Conversely, uncertainty about parameter values does not imply that policymakers have different assessments of the distributions describing those parameters.

2/ Ex post, welfare may of course be lower when policies are coordinated than when they are not; however, policies are assumed to be chosen in order to maximize expected welfare, and, on average ex post welfare is assumed to equal expected welfare.

3/ For such evidence, see Shiller (1981). Whether variance bounds tests actually demonstrate the existence of excess volatility has been questioned, however; see for instance Flavin (1983) and Flood and Hodrick (1986).

evidenced by increased volatility of stock prices. This was the experience in the days following October 19, 1987, and also in the August 1990 selloff. In such an environment, the effects of monetary and fiscal policies on ultimate target variables are also increasingly uncertain, since these policies operate through financial markets. The danger is that the real economy will suffer due to declines in real wealth and increases in the cost of capital to firms. The effects of uncertainty in domestic financial markets are compounded by uncertainty in foreign exchange markets: a sharp depreciation will have unfavorable effects on inflation, for instance, and may exacerbate loss of confidence.

Greater uncertainty in financial markets may increase the need for policy coordination because of a dilemma facing a central bank when responding to shocks. If the central bank responds to a stock market crash, for instance, by loosening monetary policy, it may bring about a collapse in the value of the currency. Fear of such a possibility might well lead to an inappropriately timid monetary policy, in which monetary expansion is kept too low. In contrast, a coordinated reduction in interest rates by central banks would diminish the risk of sharp exchange rate movements, while neutralizing the unfavorable effects of a generalized shift out of equities. In October 1987, there was in fact some coordination among central banks, or at least some consultation among them, about the need to increase liquidity, and interest rates were lowered simultaneously in all major industrial countries.

More generally, this suggests a reason why coordination may be episodic, rather than institutionalized. 1/ In times of crisis, the outlook may be very uncertain, as are the effects of policies; coordination of policies may decrease the danger of very bad outcomes. The incentives to pull together may be strengthened in such circumstances. It may be that in normal times gains from macroeconomic policy coordination are relatively small, consistent with estimates calculated using macroeconomic models. 2/ However, great uncertainty about the effects of policies may make the gains from coordination larger, for instance when financial markets are turbulent and there is a danger that portfolio shifts may lead to large movements in asset prices. As a result, macroeconomic policy coordination may take on the character of "regime-preserving coordination" (Kenen 1988) rather than a continuous attempt to maximize joint welfare, however defined.

The present paper illustrates the above discussion with a simple model with portfolio uncertainty. Section II presents a two-country, two-good model in which the portfolio preferences of investors between domestic money

1/ The terminology is due to Artis and Ostry (1986).

2/ For instance, Oudiz and Sachs (1984).

and an international equity are random variables, 1/ goods prices are sticky, and the value of financial wealth affects real output. It is shown in Section III that expected gains from policy coordination depend crucially on the perceived variances and covariances of the portfolio shifts. Policy at the time of the October 1987 crash is analyzed in the light of these results in Section IV. Section V concludes.

II. The Model

In order to highlight the interaction between portfolio preferences, asset prices, and real activity, a simple, short-run model of two countries is specified. Portfolio preferences are stochastic, and can differ in the two countries. Longer-run questions such as wage adjustment and capital accumulation are ignored. Moreover, in this stylized model, there are only three assets: domestic money, foreign money, and a single equity, which is a claim to a composite consumption good (i.e., the equity pays a real return, which is assumed exogenous). 2/ A feature of this model is thus that there is a single world equity price; this assumption reflects in extreme form the reality that co-movements of equity prices across countries have been very high in recent years--and especially so at the time of the October 1987 crash.

Each of the two countries is specialized in the production of a single good but consumes both. Utility is assumed to be Cobb-Douglas so that consumption shares are constant; in the home country, expenditure falls in proportion α on home goods and $(1-\alpha)$ on foreign goods. Consumption is assumed to be proportional to the real value of financial wealth (to be defined later), so that

$$(1) \quad C = \rho W/P$$

The consumption deflator P is a geometric average of the two goods prices, where p is the price of the home good, p^* the price of the foreign good, and s is the price of foreign currency:

$$(2) \quad P = p^\alpha (sp^*)^{1-\alpha}$$

1/ A number of articles have included equity markets in macroeconomic models, for instance Diamond (1967) and Helpman and Razin (1978). In the present paper, there is no attempt to model capital accumulation, or to relate the riskiness of equities to technological uncertainty. Instead, it is the risk related to shifts in portfolio preferences that is at issue here.

2/ Thus, the "fundamentals" are not the cause of asset price volatility. A more complicated model could make both production technology and portfolio preferences stochastic.

Consistent with Cobb-Douglas utility, consumption is divided between the home good (C_1) and the foreign good (C_2) on the basis of fixed spending shares:

$$(3) \quad C_1 = \alpha(P/p)C$$

$$(4) \quad C_2 = (1-\alpha)(P/sp^*)C$$

In what follows we will assume that for both the home and foreign countries, spending falls equally on the two goods so that $\alpha=1/2$. Therefore, equations (2) and (3) can be written as follows:

$$(5) \quad P = (p \text{ } s \text{ } p^*)^{1/2}$$

$$(6) \quad C_1 = .5(P/p)C$$

$$(7) \quad C_2 = .5(P/sp^*)C$$

Wealth is held in the form of money M , which is non-traded, and in international equities E , which are a promise to pay a given amount of the composite consumption good (which is the same in the two countries since $\alpha=\alpha^*=1/2$), and for which there is a single world market. Money and equities are held in proportions m and $(1-m)$; these proportions are random variables. The price of a real equity claim is q :

$$(8) \quad M = mW$$

$$(9) \quad qPE = (1-m)W$$

Uncertainty in portfolio preferences is reflected in the variance of m . Shifts in domestic portfolio preferences may or may not be correlated with shifts in the preferences of foreign investors; the degree of correlation is shown below to be crucial to gains from coordination.

A symmetric foreign country has a similar structure, indicated by starred variables. Parameters are assumed identical, except the random portfolio share parameter, m^* , which may not be equal to m (in the next section the distributions describing m and m^* are, however, assumed to be the same). There is a single world equity price (i.e., $q^* = q$) since both home and foreign equities pay returns in the same consumption basket. The counterparts of equations (1) and (5)-(9) are:

$$(1') \quad C^* = \rho W^*/P^*$$

$$(5') \quad P^* = [(p/s) p^*]^{1/2}$$

$$(6') \quad C_1^* = .5(sP^*/p)C^*$$

$$(7') \quad C_2^* = .5(P^*/p^*)C^*$$

$$(8') \quad M^* = m^*W^*$$

$$(9') \quad qP^*E^* = (1-m^*)W^*$$

It is assumed that output prices are sticky, and that p and p^* are fixed in the short run; output is determined by demand:

$$(10) \quad y = C_1 + C_1^*$$

and

$$(10') \quad y^* = C_2 + C_2^*$$

However, consumer prices can vary since the exchange rate s is flexible. Similarly, the price of equities q moves to equate the demand for equities and the outstanding stock of equity shares $K + K^*$, where K and K^* are the initial endowments of equities at home and abroad:

$$(11) \quad K + K^* = E + E^*$$

The exchange rate is determined by an equilibrium condition that the current account surplus equal the capital account outflow, which is equivalent to the condition that the distribution of equities between the two countries satisfies portfolio preferences. The net capital outflow CAP from the home country (i.e., net purchases of equities) is equal to

$$(12) \quad \text{CAP} = qP(E - K)$$

(which is of course equal, from (11), to $-qP(E^* - K^*)$, the inflow to the foreign country, which corresponds to net sales of equities). The current account surplus CUR is the excess of domestic output over domestic absorption (i.e., saving), or exports minus imports:

$$(13) \quad \text{CUR} = (y - C_1)p - s(y^* - C_2^*)p^*,$$

and the balance of payments condition is

$$(14) \quad \text{CAP} = \text{CUR}$$

III. Optimal Government Policy

In the context of this model, monetary policy has a role in cushioning portfolio preference shifts, which have real effects because prices are sticky and consumption depends on wealth. We will consider the optimal monetary policy of a government, or central bank, that desires to minimize deviations from target output $\bar{y}$ --presumably its full employment level--and price stability, which implies that the price level equals its initial equilibrium value $\bar{P}$. We postulate for reasons of tractability a quadratic objective function of deviations from bliss levels. Such a formulation implies a symmetric treatment of positive and negative deviations, which is probably not realistic; however, we will only consider a portfolio shift out of equities into money that tends to depress output. In particular, we consider the optimal response of the money supply to a shock to the mean value of investors' portfolio preferences, in the face of uncertainty about these preferences.

Suppose that the home government's objective function is

$$(15) \quad L = E((y/\bar{y}-1)^2 + \phi(P/\bar{P}-1)^2)$$

and similarly for the foreign government

$$(15') \quad L^* = E((y^*/\bar{y}^*-1)^2 + \phi(P^*/\bar{P}^*-1)^2)$$

We will assume that in initial equilibrium, money supplies and asset proportions are equal, so that $M=M^*=\bar{M}$ and $1/m=1/m^*=\bar{n}$, and so $\bar{s}=1$, and $p=p^*=1$. Consider a shift out of equities at home and abroad, so that now

$$(16) \quad E(1/m) = E(n) - E(n^*) = \theta\bar{n},$$

with $\theta < 1$. How does the optimal setting for monetary policy in the two countries, if each takes the other's policy as given, compare to the case of joint maximization of an equally-weighted global objective function G , where $G = .5(L + L^*)$?

In the absence of uncertainty, it can be shown that the optimal response to such a shock will--not surprisingly--be to accommodate fully the increase in liquidity preference. In this case, the Appendix shows that cooperative and non-cooperative policy settings are the same; they both involve an increase in money supply by the increase in money demand, so $M = M^* = \bar{M}/\theta$. If there is no uncertainty, then in this model monetary policy can completely neutralize the negative output effects of the portfolio preference shock, and the non-cooperative and cooperative policies are the same. However, if there exists uncertainty about portfolio preferences, then only in the case where the portfolio shifts in the two countries are expected to be perfectly correlated will the two policies be the same.

It can be shown (see Appendix) that in general--unless the weight on inflation in the objective function is zero--the optimal non-cooperative policy will be too contractionary, relative to the optimal, cooperative solution. The reason for this bias is the externality associated with the exchange rate: appreciation helps in moderating domestic prices, while the negative effects on the foreign country are ignored in the absence of cooperation. The difference between the non-cooperative and cooperative policies, and hence the gains from policy coordination, depend both on the common variance σ^2 of portfolio preferences and on the correlation κ between the two countries' portfolio preference shifts--directly in the first case, and inversely in the second.

The difference between the two policies increases monotonically as the correlation declines, and is maximized when their correlation is minus unity, i.e. they are perfectly negatively correlated. In this case, governments set policy with the risk that a monetary expansion may lead to a large exchange rate depreciation because portfolio preferences of domestic and foreign residents for money and equities are expected to shift in ways

that reinforce their effects on the exchange rate. The depreciation is undesirable because of its price level effects.

This example provides an additional reason why policy coordination may be beneficial, compared to the traditional literature in which the effects of policies are assumed to be known. In Sachs (1985), for instance, non-cooperative monetary policies are too contractionary in response to an inflation shock because exchange rate appreciation improves the output/inflation tradeoff, and there are two targets and only one instrument. In the present example, the effects of policies are uncertain because of possible portfolio preference shifts, so that even if each government has as many instruments as targets it still has an incentive to coordinate. The fact that portfolio preferences are uncertain and that they contribute to the variance of the exchange rate makes uncoordinated policies over-contractionary in the face of an increase in liquidity preference.

IV. The Stock Market Crash of October 1987

On October 19-20, 1987, the world's stock markets declined in a sudden selloff of shares by investors. In local currency terms, stock market indices declined in the period September 30-October 31 by 21.5 percent in the United States, 26.1 percent in the United Kingdom, 22.9 percent in Germany, and 12.6 percent in Japan (see Figure 1 for a visual impression of the comovements of major market indices). Other declines were even more dramatic: 58.3 percent in Australia and 56.3 percent in Hong Kong (FRBNY 1988, p.18). To a large extent, therefore, at least during this period world equity markets seemed globally integrated--as is assumed in the model described above, in which there is only one equity market--though the reasons for the common movement of prices are subject to dispute. To some extent, this may be the result of the gradual increase in interlisting of shares on different exchanges; however, correlations between the main trading zones increased by a factor of three from their levels in the previous nine months (Bertero and Mayer 1989). Common movements in October 1987 did not seem to result from significant international investment flows, since cross-border selling was relatively small (FRBNY 1988, p. 34). More fundamentally, then, increased economic integration and the globalization of information led to a common reassessment of equity prices in all major stock markets at the time of the stock market crash.

Confirming the generalized shift out of equities, as opposed to a shift in investor sentiment affecting only one or a few countries, the sharp decline in equity values was associated with relatively small exchange rate movements (Figure 2). In contrast, a shift in portfolio preferences away from the equities of a single country (whether on the part of residents or of both resident and non-resident investors), could be expected to lead to currency depreciation. In the October 1987 crash, exchange rate movements

do not seem to have been a consideration in the setting of monetary policies. ^{1/}

What does seem to have been a major concern influencing policy was that the 1987 stock crash might be a replay of the 1929 one, which was followed by the Great Depression (Schwartz 1988). In this regard, a high degree of uncertainty attached to the linkage between the stock market and the real economy--that is, the spending propensities of consumers, whose wealth had declined, and businesses, whose investment plans might be scaled back reflecting increased caution. Also subject to increased uncertainty was the stability of the financial system: whether the inability of individuals to cover margin calls, or of financial institutions to transact in financial markets, would lead to bankruptcies, and whether anticipation of such problems would cause the clearing and settlements system to collapse (Bernanke, 1990). Uncertainty about the behavior of financial system is modeled above as increased variance of the proportion of assets held in money and equities. It is hard to quantify the increase in uncertainty; however, one measure, the expected volatility implied by a comparison of equity and options prices, showed a dramatic increase in the United States in October 1987 (Figure 3).

Fear of financial collapse led governments and central banks to intervene by providing liquidity; moreover, they did so through closely coordinated actions. Of course, given the importance of the United States in world financial markets, the actions of the U.S. authorities were of paramount importance. The Federal Reserve reversed its tight monetary stance, flooding the system with liquidity; persuaded the banks to lend freely to securities firms; and monitored closely the situation, taking direct action where necessary (Bernanke 1990). However, it did not act in isolation: "... we closely monitored the international ramifications of the stock market crash ... We communicated with officials of foreign central banks..." (Greenspan 1988, p. 92). In describing the role of G-7 policy coordination in this period, Dobson says:

"The risk in 1987 was that, in the absence of close G-7 cooperation, the financial crisis could have turned into an economic crisis. Had the authorities turned their backs and refused to cooperate among themselves, it is very likely that the crisis would have deepened."
(Dobson 1991, p. 128)

What occurred was a generalized decline in short-term interest rates as all central banks expanded liquidity (Figure 4). To some extent, a decline in interest rates on government paper (though not on private claims) might be expected from a "flight to quality," but clearly central banks favored a fall in rates:

^{1/} They are not mentioned, for instance, in Alan Greenspan's testimony at hearings on "Black Monday" held by the U.S. Senate Committee on Banking, Housing, and Urban Affairs, February 2-5, 1988. See Greenspan (1988).

Figure 1. Stock Market Prices, January 1985 to September 1990
(Indices. 1985 = 100)

Figure 2. U.S. Dollar Exchange Rates, January 1985 to December 1990
(Indices, 1985 = 100)

Figure 3. Implied Volatility of S&P 500
January 1, 1987 to October 12, 1990

Source: Salomon Brothers. Calculated using the Black-Scholes option price formula, adjusted for dividend payments, and using the price of a put option on the Standard and Poor's 500 Stock Index and the interest rate on U.S. Treasury Bills.

Figure 4: Short-term Interest Rates, January 1985 to December 1990

"By helping to reduce irrational liquidity demands, and accommodating the remainder, the Federal Reserve avoided a tightening in overall pressures on reserve positions and an increase in short-term rates. In fact, we went even further and eased policy moderately following the stock market collapse in light of the greater risk to continued economic expansion." (Greenspan 1988, p. 90)

In sum, therefore, the October 1987 stock market crash is an example where there seems to be a direct link between increased uncertainty and increased policy coordination. In describing the risks to the clearing and settlement system posed by the October 1987 and other events, the Governor of the Bank of Canada has stated:

"These disturbances, and others since, were effectively contained through co-operation among major market participants... [T]he temporary injection of liquidity by central banks ... helped to prevent the October 1987 financial problems from degenerating into solvency problems. In retrospect, it is clear that the global community has come altogether too close to situations where market difficulties could have been severe enough to inflict lasting damage on financial markets and even on national economies." (Crow 1990, p. 2)

The model developed above has suggested that the need for policy coordination might have been even greater if the portfolio shifts had been less symmetric, for instance if the fall in equity prices had been associated with severe weakness of the U.S. dollar. In this case, the Federal Reserve might have been much less willing to expand liquidity, for fear of adding to a run on the dollar. In cases such as these, a coordinated decline in interest rates in all countries would diminish the risk of disruptive exchange rate movements.

V. Conclusions

The paper has illustrated in a simple model the link between uncertain portfolio preferences of private investors and the difference between coordinated and uncoordinated policies. Greater uncertainty makes coordination more desirable in this example where portfolio shifts generate variations in output and exchange rates. The analysis suggests that if the perceived degree of uncertainty varies over time--perhaps as described in recent articles, for instance by Flood, Bhandari and Horne (1988)--then the incentives to coordinate policies will also vary. In particular, in situations of great uncertainty, where the prevailing international monetary system is threatened, policies are more likely to be influenced by shared goals.

In the particular source of uncertainty that is considered in the paper--uncertainty on the part of policymakers about the portfolio preferences of private investors--the degree of correlation across countries of portfolio shifts between equities and money is crucial in determining the gains from policy coordination. In more general models with a wider menu of

traded assets, in which portfolio shifts may also occur between different countries' equities and bonds, the conclusion is likely to remain. Paradoxically, if portfolio shifts are expected to be correlated across countries--as was the case out of equities at the time of the October 1987 crash--they may not require policy coordination to the extent that less symmetric portfolio preference shifts would. Of course, what is important is the anticipation by policymakers of the nature of portfolio shifts, and these anticipations are unlikely to involve perfect correlation. Moreover, the more widespread are declines in asset prices, the greater is the threat to global financial stability. It seems likely therefore that, in general, uncertainty about the investors' preferences provides an independent incentive to coordinate policies internationally.

Solution of the Model

The solution for the variables that are of interest to us--we assume that policymakers have targets for domestic output and consumer prices--can be obtained as follows. Domestic output prices (but not consumer prices) are fixed in the current period. From (5) and (5') in the text,

$$(A1) \quad P^* = P/s$$

As a result, from (1), (8), and (A1)

$$(A2) \quad C = \rho(M/m)/P$$

$$(A2') \quad C^* = s\rho(M^*/m^*)/P$$

From the conditions for goods market equilibrium, (10) and (10'),

$$(A3) \quad y = .5[\rho M/m + s\rho M^*/m^*]/p$$

$$(A3') \quad y^* = .5[\rho(M/m)/s + \rho M^*/m^*]/p^*$$

Turning to equilibrium in financial markets, substituting (9), (9') into (11) yields

$$(A4) \quad qP = \{(1-m)M/m + (1-m^*)sM^*/m^*\}/(K + K^*)$$

Now the balance of payments equilibrium can also be expressed in terms of s and q ; from (12)-(14):

$$(A5) \quad qP(E - K) = .5\rho(sM^*/m^* - M/m)$$

Substitution of (9) and (A4) into (A5) yields an expression for s in terms of money supplies, portfolio preferences, and initial endowments of equities:

$$(A6) \quad s = \{(1-m)[K^*/(K + K^*)]M/m + .5\rho M/m\}/\{(1-m^*)[K/(K + K^*)]M^*/m^* + .5\rho M^*/m^*\}$$

In keeping with our assumption of symmetry, we further posit that initial endowments of the international equity are equal, so that $K/(K + K^*) = 0.5$. Therefore, the exchange rate can be written as

$$(A7) \quad s = [(M/m)(1-m + \rho)]/[(M^*/m^*)(1-m^* + \rho)]$$

Thus, for given portfolio preferences, the exchange rate is determined by relative money supplies; a shift out of equities into money (an increase in m) will tend to appreciate the currency (lower s).

Using the expression for s , we can derive reduced-form expressions for domestic and foreign outputs. From (A3),

$$(A8) \quad y = \rho(M/m) \{ [1 - .5(m + m^*) + \rho] / (1 - m^* + \rho) \} / p$$

and from (A3'),

$$(A8') \quad y^* = \rho(M^*/m^*) \{ [1 - .5(m + m^*) + \rho] / (1 - m + \rho) \} / p^*$$

We will assume that it is not possible to go short in equities, so that $1 - m > 0$ and $1 - m^* > 0$. Therefore, the terms in () in (A8) and (A8') are positive, implying that an increase in the money supply in the home country increases output:

$$\partial y / \partial M > 0 \quad \text{and} \quad \partial y^* / \partial M^* > 0$$

while an increase in the desire to hold domestic money decreases it:

$$\partial y / \partial m < 0 \quad \text{and} \quad \partial y^* / \partial m^* < 0$$

In contrast, portfolio shifts abroad have the opposite effect (i.e. they are negatively transmitted); it can be shown that

$$\partial y / \partial m^* > 0 \quad \text{and} \quad \partial y^* / \partial m > 0.$$

The first-order condition for optimal policy setting in the home country can be derived in the following way. Let $n = 1/m$, $n^* = 1/m^*$, and $F(n, n^*) = [(\rho + 1)n - 1] / [(\rho + 1)n^* - 1]$, and note that both numerator and denominator of F are positive, from the assumption made above that portfolio shares must be positive. From equations (A7) and (A8) above,

$$(A9) \quad \begin{aligned} \partial L / \partial M &= E \{ .5M[n + n^*F(n, n^*)]^2 / \bar{M}^2 \bar{n}^2 \\ &\quad - [n + n^*F(n, n^*)] / \bar{M} \bar{n} + \phi[F(n, n^*) / M^*] \\ &\quad - \phi[F(n, n^*) / M^* M]^{1/2} \} = 0 \end{aligned}$$

Given the assumptions of symmetry, implying that $F(n^*, n) = 1/F(n, n^*)$, the foreign country's first-order condition is similar, and is not presented here.

Consider an equal change in the two countries in portfolio preferences, such that the desired wealth proportion held in the form of money rises equally, i.e., n and n^* fall by the same amount. It is clear that, starting from the same position, the optimal policy response to the same portfolio shock will be the same in the two countries, so that $M = M^*$. Replacing M^* and M by M^n , the common non-cooperative policy setting, we obtain from (A9)

$$(A10) \quad \begin{aligned} M^n &= 2[\bar{M} \bar{n}] E[n + n^*F(n, n^*)] / E[n + n^*F(n, n^*)]^2 \\ &\quad - [2\phi / M^n] (E[F(n, n^*)] - E[F(n, n^*)]^{1/2}) \bar{M}^2 \bar{n}^2 / \\ &\quad E[n + n^*F(n, n^*)]^2 \end{aligned}$$

If the two governments instead coordinate and minimize a joint objective function G that gives equal weights to L and L^* , then the first-order condition for the use of the home country's money supply instrument is

$$(A11) \quad \begin{aligned} \partial G / \partial M = & E\{.5M[n + n^*F(n, n^*)]^2 / \bar{M}^2 \bar{n}^2 \\ & - [n + n^*F(n, n^*)] / \bar{M} \bar{n} + \phi[F(n, n^*) / M^*] \\ & - \phi F[(n, n^*) / M^* M]^{1/2} - \phi F(n^*, n) (M^* / M^2) \\ & + \phi (MM^*)^{1/2} [F(n^*, n)]^{1/2} / M\} = 0 \end{aligned}$$

Not surprisingly, the first-order condition for M^* is symmetrical, and therefore it will not be presented. Solving (A11) for the common coordinated money supply setting M^C ,

$$(A12) \quad \begin{aligned} M^C = & [2\bar{M}\bar{n}]E[n + n^*F(n, n^*)] / E[n + n^*F(n, n^*)]^2 \\ & - [\bar{M}^2 \bar{n}^2 \phi / M^C] (E[F(n, n^*)] - E[F(n, n^*)]^{1/2} \\ & - E[F(n^*, n)] + E[F(n^*, n)]^{1/2}) \end{aligned}$$

Equation (A12) simplifies further in the case (assumed here) where the distributions describing portfolio preference parameters are the same in the two countries, though not necessarily their realizations. In this case, $EF(n, n^*) = EF(n^*, n)$ and $EF(n, n^*)^2 = EF(n^*, n)^2$. Therefore, the term of (A12) between { } is zero and the cooperative monetary policy is given by

$$(A13) \quad M^C = [2\bar{M}\bar{n}]E[n + n^*F(n, n^*)] / E[n + n^*F(n, n^*)]^2$$

In this case, though each country's objective includes inflation, and hence, indirectly, the exchange rate (and both countries' inflation targets are included symmetrically in G), the exchange rate plays no role in the cooperative monetary policy: the latter, given by (A13), is independent of the value of ϕ .

What is the effect of increased liquidity preference in the two countries, under each policy regime? First assume absence of uncertainty. In this case, since $n = n^* = \theta \bar{n} < \bar{n}$

$$EF(n, n^*) = EF(n^*, n) = E[F(n, n^*)]^{1/2} = E[F(n^*, n)]^{1/2} = 1$$

and

$$E[n + n^*F(n, n^*)] = 2\theta n.$$

It can be verified from (A10) and (A13) that

$$(A14) \quad M^n = M^C = \bar{M} / \theta,$$

so that both policy regimes fully accommodate the shift in liquidity preference. In the absence of uncertainty, no negative exchange rate repercussions are to be feared from a symmetric portfolio shift.

Next, consider the effect of an increase in uncertainty in the two policy regimes, starting from the initial position with a common monetary policy stance $M = M^* = \bar{M}$, and letting $E(n) = E(n^*) = \bar{n}$. The only element of uncertainty will relate to the common variance of n , i.e.,

$$E(n - \bar{n})^2 = E(n^* - \bar{n})^2 = \sigma^2.$$

In order to evaluate expressions on the right hand sides of (A10) and (A13), first take a second-order Taylor series expansion of $F(n, n^*)$ and $F(n, n^*)^{1/2}$ around $E(n) = \bar{n}$, and $E(n^*) = \bar{n}$, and take expectations (letting $\text{var}(n) = \text{var}(n^*) = \sigma^2$, $\text{cov}(n, n^*) = \kappa\sigma^2$, and $\beta = [(\rho+1)\bar{n} - 1]^{-2}$):

$$(A15) \quad EF(n, n^*) \doteq 1 + (\rho+1)^2\beta(1-\kappa)\sigma^2$$

$$(A16) \quad EF(n, n^*)^{1/2} \doteq 1 + (\rho+1)^2\beta(1-\kappa)\sigma^2/4$$

From approximations (A15) and (A16) it can be shown that

$$(A17) \quad EF(n, n^*) - EF(n, n^*)^{1/2} \doteq 3(\rho+1)^2\beta\sigma^2(1-\kappa)/4 \geq 0$$

$$(A18) \quad E[n + n^*F(n, n^*)] \doteq 2\bar{n} + (\rho+1)\beta\sigma^2(1-\mu)$$

$$(A19) \quad E[n + n^*F(n, n^*)]^2 \doteq 4\bar{n}^2 + 4\sigma^2 + 2[4(\rho+1)\bar{n} - 1]\beta\sigma^2(1-\kappa).$$

From (A10), (A13), and (A15)-(A19), it can be shown that increased uncertainty (a larger σ^2) makes both non-cooperative and cooperative policies more contractionary but it increases the gap between them (unless $\kappa=1$): evaluated at $\sigma^2 = 0$,

$$\frac{dM^c}{d\sigma^2} - \frac{dM^n}{d\sigma^2} = \frac{(\phi/2)\bar{M}}{1+\phi/2} [(3/4)(\rho+1) + 1/2\bar{n}](\rho+1)\beta(1-\kappa) > 0$$

Thus, a moderate amount of uncertainty will imply gains from coordination. The general case is however ambiguous; starting from a position where $\sigma^2 > 0$, the effect of additional uncertainty cannot be signed.

References

- Artis, Michael, and Sylvia Ostry, International Economic Policy Coordination, Chatham House Papers No. 30, Royal Institute of International Affairs (London: Routledge and Kegan Paul, 1986).
- Bernanke, Ben S., "Clearing and Settlement During the Crash," Review of Financial Studies, vol. 3, no. 1 (1990), pp. 133-51.
- Bertero, Elisabetta, and Colin Mayer, "Structure and Performance: Global Interdependence of Stock Markets Around the Crash of October 1987," Centre for Economic Policy Research Discussion Paper No. 307, March 1989.
- Cooper, Richard N., "Economic Interdependencies and Coordination of Policies," in R.W. Jones and P.B. Kenen, eds. Handbook of International Economics, vol. 2 (Amsterdam, North-Holland, 1985).
- Crow, John W., "Note for Remarks at the Treasury Management Association of Canada's Eighth Annual Cash and Treasury Management Conference," BIS Review, No. 231, November 26, 1990, pp. 1-6.
- Currie, David, Paul Levine and Nic Vidalis, "International Cooperation and Reputation in an Empirical Two-Bloc Model," in Global Macroeconomics: Policy Conflict and Cooperation, ed. by Ralph Bryant and Richard Portes (New York: St. Martin's, 1987), pp. 75-127.
- Diamond, Peter, "The Role of a Stock Market in a General Equilibrium Model with Technological Uncertainty," American Economic Review, vol. 57 (December 1967), pp. 759-76.
- Dobson, Wendy, Economic Policy Coordination: Requiem or Prologue?, Policy Analyses in International Economics No. 30 (Washington, D.C.: Institute for International Economics, 1991).
- Federal Reserve Bank of New York (FRBNY), Quarterly Review, vol. 13 (Summer 1988).
- Feldstein, Martin, "Distinguished Lecture on Economics in Government: Thinking about International Economic Coordination," Journal of Economic Perspectives, vol. 2 (Spring 1988), pp. 3-13.
- Flavin, Marjorie, "Excess Volatility in the Financial Markets: A Reassessment of the Empirical Evidence," Journal of Political Economy, vol. 91 (December 1983), pp. 929-56.
- Flood, Robert P., Jagdeep S. Bhandari, and Jocelyn P. Horne, "Evolution of Exchange Rate Regimes," IMF Working Paper No. 88/106, December 9, 1988.

- Flood, Robert P. and Robert J. Hodrick, "Asset Price Volatility, Bubbles, and Process Switching," Journal of Finance, vol. 41 (September 1986), pp. 831-42.
- Frankel, Jeffrey and Katharine Rockett, "International Macroeconomic Policy Coordination when Policy-Makers Do Not Agree on the True Model," American Economic Review, vol. 78 (June 1988), pp. 318-40.
- Ghosh, Atish and Swati Ghosh, "International Policy Coordination When the Model is Unknown," mimeo, Geneva, Switzerland, December 1986; forthcoming in the Journal of International Economics.
- Ghosh, Atish and Paul R. Masson, "International Policy Coordination in a World with Model Uncertainty," IMF Staff Papers, vol. 35 (June 1988), pp. 230-58.
- Greenspan, Alan, Testimony at Hearings before the Committee on Banking, Housing, and Urban Affairs of the U.S. Senate, on " 'Black Monday,' The Stock Market Crash of October 19, 1987" (Washington, D.C.: U.S. Government Printing Office, 1988), pp. 88-100.
- Helpman, Elhanan and Assaf Razin, "Uncertainty and International Trade in the Presence of Stock Markets," Review of Economic Studies, vol. 45 (June 1978), pp. 239-50.
- Kenen, Peter B., "Exchange Rates and Policy Coordination in an Asymmetric Model," Centre for Economic Policy Research, Discussion Paper No. 240, May 1988.
- Martinez Oliva, Juan Carlos and Stefan Sinn, "The Game-Theoretic Approach to International Policy Coordination: Assessing the Role of Targets," Weltwirtschaftliches Archiv, Band 124, Heft 2 (1988), pp. 252-68.
- Oudiz, Giles and Jeffrey Sachs, "Macroeconomic Policy Coordination among Industrial Economies," Brookings Papers on Economic Activity, 1:1984, pp. 1-75.
- Sachs, Jeffrey, "The Dollar and the Policy Mix: 1985," Brookings Papers on Economic Activity, 1:1985, pp. 117-97.
- Schwartz, Anna, "The 1987 U.S. Stock Market Crash," Economic Affairs, vol. 8 (February/March 1988).
- Shiller, Robert J., "Do Stock Prices Move Too Much to Be Justified by Subsequent Changes in Dividends?" American Economic Review, vol. 71 (June 1981), pp. 421-36.