WORKING PAPERS
IN ECONOMICS

INTERNATIONAL MONETARY AND FISCAL POLICY COOPERATION IN THE PRESENCE OF WAGE INFLEXIBILITIES

by

Jeffrey Sheen

No. 130 October 1989

DEPARTMENT OF ECONOMICS

The University of Sydney
Australia 2006

INTERNATIONAL MONETARY AND FISCAL POLICY COOPERATION IN THE PRESENCE OF WAGE INFLEXIBILITIES

by

Jeffrey Sheen

No. 130 October 1989

ABSTRACT

This paper studies the transmission mechanisms and welfare implications of strategic monetary and fiscal policy in a two country, Mundell-Fleming, variable supply, stochastic model. The issue of the counterproductivity of policy cooperation, raised by Rogoff (1985) is examined and extended to fiscal policy. It is established that systematic fiscal policy cooperation is productive for a wide range of parameter values that include those of the simple Keynesian model. Cooperation is always productive for policy that is contingent on the realisation of shocks.

National Library of Australia Card Number and ISBN 0 949269 94 8

INTERNATIONAL MONETARY AND FISCAL POLICY COOPERATION IN THE PRESENCE OF WAGE INFLEXIBILITIES

Are both counterproductive?

by
Jeffrey Sheen

SECTION 1 Introduction

Since World War II, the world's major economies have experienced a remarkable degree of liberalisation and internationalisation of their markets for goods and assets. The surge in international trade and the appearance of major global supply and demand shocks has meant that the question of international cooperation of macroeconomic policy had to arise. Academic analysis began in the 1960's and the major early contributors in this field were Cooper (1969) and Hamada (1976) who focussed on fixed exchange rate regimes. Subsequently, in the 1980's, attention shifted to flexible exchange rate regimes with contributions by many authors such as Canzoneri and Gray (1985), McKibbin and Sachs (1988). In this latter literature that involves static games, all lend support to the notion that *international policy cooperation will be beneficial*. From the theory of simple games, this was to be expected.

The same issues have been addressed in the context of dynamic games by many authors - for example, see the Buiter and Marston (1985) volume and Taylor (1985). The question of time-consistency is shown to be crucial in establishing the properties of equilibria - heuristically speaking, in a time-consistent equilibrium, planned future optimal paths remain optimal as time passes. The paper that we focus attention on in this paper is by Rogoff (1985) who imposed time-consistency on a two country Mundell-Fleming model where wage setters *do not cooperate with their governments*. Rogoff (1985) obtained the interesting result that international monetary cooperation was 'counterproductive', an outcome which can be explained by the theory of the second-best. With regard to systematic monetary policy, with the natural rate of output below the government's target, cooperation suffers from the absence of the exchange rate depreciation threat that is present in a non-cooperative circumstance. For policy that is contingent on unexpected shocks, Rogoff showed that cooperation is 'productive'.

The definition of 'counterproductive cooperation' needs to be interpreted carefully. In fact, by *restricting attention to sub-game perfect equilibria* i.e. *sequential* equilibria obeying rational expectations and time-consistency, it is easy to show that the monetary authorities will always choose to cooperate in the period after the one in which wages were precommitted (see Carraro and Giavazzi (1988)). To construct a perfect equilibrium, one must work backwards as in dynamic programming. Whatever the wage that was selected in a previous period (i.e. based on an expectation of cooperation or otherwise), the governments will always have an incentive to cooperate because in the current period, bygones are bygones. Knowing that governments will choose to cooperate *ex-post*, it is rational for workers to expect cooperation, and so cooperation is the only sub-game perfect equilibrium. Thus a comparison of the cooperative and the rational Nash outcomes does not constitute an equilibrium regime exercise. Instead the comparison tells us whether or not cooperation, which will be optimal *ex-post*, is Pareto-dominated by the Nash outcome *ex-ante*. If it is dominated, then institutional redesign will be required to bring about the better Nash equilibrium. In this paper, we shall observe this interpretation of 'counterproductivity'.

This paper extends the monetary analysis to fiscal policy cooperation. Indeed there is already a growing literature on international transmission and cooperation of fiscal policies. One important strand has followed the route of using a representative utility function for assessing social welfare (for example, see Frenkel and Razin (1986), Turnovsky (1988)). This approach avoids all the well known and obvious weaknesses of using ad hoc linear quadratic loss functions; nevertheless it is equally well known that extreme and unrealistic assumptions are needed to construct a sensible social welfare function from an aggregation of individual preferences. Given these matching weaknesses, this paper stays with the more tractable linear quadratic methodology.

We show that for a range of parameter values consistent with very familiar macro-models, in particular the simple Keynesian one, systematic fiscal policy cooperation turns out to be Pareto-optimal. Further, it is shown that cooperative contingent fiscal policy is always productive, a theoretical result which has full measure of agreement in the literature. These important results imply that it may be vital to remove any impediments that prevent fiscal authorities from cooperating. Considering the condition of the global economy of the 1980's, it would be difficult to find anyone who would disagree with the diagnosis that grossly uncoordinated national fiscal policies amongst the major industrial countries are a major problem.

With regard to fiscal policy cooperation, Turnovsky (1988) found that the Nash solution involves excessive fiscal spending (on the imported good) compared with cooperation. We consider an analogue of this issue and find that this result is borne out if the governments' output target exceeds the natural rate.

The structure of the paper is as follows. In section 2, the general stochastic two country Mundell-Fleming model with variable output supply is explained. It is shown how various

familiar sub-models are encompassed by this general one. Reduced form solutions are then obtained and policy transmission mechanism explained. In section 3, strategic policy analysis is undertaken. Nash solutions are compared with cooperative ones for systematic and contingent policies. We first assume fiscal policy to be passively neutral, and consider activist monetary policy; then we do the reverse. Section 4 contains some concluding comments.

SECTION 2 The Model

For the two countries, there are markets for goods, money, capital and labour. Factors of production are internationally immobile, and apart from wages all prices adjust freely to clear markets. For simplicity, the countries are assumed to be completely symmetrical - nevertheless the goods they produce are not perfect substitutes. The symmetry means that only the domestic economy equations need to be specified explicitly. A star (*) has a foreign connotation. The model has fundamental dynamics because wage contracts will be set at the start of the analysis period, prior to the realisations of random shocks.

Output is produced by a constant returns to scale technology with labour and fixed capital. Firms choose employment to equate the actual product wage with the marginal product. Output supply (in logarithms) becomes a linear function of the real product wage:

$$y^s = -\theta (w - p) + u_s \tag{1}$$

$$\bar{y} = 0 \tag{2}$$

where θ is the ratio of the shares of labour and capital in output, u_s is an independent serially uncorrelated random supply shock with mean 0, w and p are the logarithms of the nominal wage and the domestic product price. The parameter θ will play an important role in the analysis of fiscal policy cooperation. With the constant in (1) normalised to zero and the 'natural' rate of output, $\bar{y}$, assumed to be zero, the 'natural' product wage and rental rate is also zero. In fact, this natural rate of output will be interpreted in this model as the level of output targetted by wage-setters.

A wage contract is set *ex-ante* specifying a base wage rate, $\bar{w}$, and an indexation clause for price index innovations:

$$w = \bar{w} + \beta\,(P - EP) \tag{3}$$

where

$$P = \alpha p + (1-\alpha)(e + p^*) \tag{4}$$

and E is the *ex-ante* expectation operator, e is the logarithm of the domestic nominal exchange rate, p^* is the logarithm of the foreign product price and α is the share of local goods in the consumption basket.

If indexation is perfect, $\beta=1$, then the model exhibits *real consumption wage rigidity* - denoted RWR henceforth. If there is no indexation, $\beta=0$, we have *nominal wage rigidity* - henceforth NWR. If there is no indexation and $\theta\to\infty$, then $w=p=\bar{w}$ and the model can be described as simple fixprice *Keynesian* - or K. Finally if $\theta=0$, we have a *classical* - or C - model with exogenous output. These four macroeconomic models are encompassed in our general framework, and their contrasting properties will be brought out in the discussion.

Wage-setters select that base wage which minimises the expected quadratic deviation of output from their particular target : $E(y^s-\bar{y})^2$. By substituting in (1)-(4), the optimal base wage is:

$$\bar{w} = Ep - \bar{y}/\theta = Ep \tag{5}$$

This base wage result plays a very important role in the model to be developed. The expected domestic price will depend upon the international policy regime because in general cooperative and non-cooperative regimes have different incentives for policy. A critical aspect is the fact that wage-setters and their respective governments do not cooperate.

Noting our definition of the real exchange rate, $\varepsilon = e + p^* - p$, output supply can now be rewritten as:

$$y^s = \theta(1-\beta)\,(p - Ep) - \theta\beta(1-\alpha)\,(\varepsilon - E\varepsilon) + u_s \tag{6}$$

which is an open economy version of the surprise-supply function featured in the New Classical macroeconomic paradigm (see Lucas and Sargent (1981)). The important point to notice is that an unexpected exchange rate depreciation can contract output because it triggers wage increases via the indexation mechanism.

Aggregate demand for output depends in the usual way on the real exchange rate, the expected real interest rate, foreign output and the fiscal deficit:

$$y^d = \delta\varepsilon - \sigma(i - E\pi_+) + \psi y^* + \gamma f + u_d \tag{7}$$

where π_+ is the first lead in the rate of change in the price index, i is the nominal interest rate, f represents the fiscal deficit[1] and u_d is an independent serially uncorrelated random demand shock with mean zero. The real exchange rate, foreign output and fiscal elasticities are assumed to be positive and less than one. *Ex-post*, y^d and y^s are equated by the market.

Domestic and foreign assets are assumed to be perfect substitutes and financial capital is perfectly mobile. Thus uncovered interest parity is assumed to prevail so that:

$$i = i^* + Ee_+ - e \tag{8}$$

Finally money market equilibrium implies that the real money supply equals demand with the latter depending on the nominal interest rate and output:

$$m = P - \lambda i + \phi y + u_m \tag{9}$$

where m is the logarithm of the money stock, u_m is a serially uncorrelated random monetary demand shock with mean 0. The interest elasticity λ shall be assumed to be positive and less than one.

2.1 *The Equilibrium Solution*

The process of solving this model under rational expectations is not trivial and it will help considerably to anticipate the nature of the full equilibrium. Given the perfect symmetry of the two country model, it will become apparent that there will be equilibria where key variables have the same values for both countries, viz. m, p, $\bar{w}$, y and i, and that e and ε will be zero.[2]

The monetary and fiscal authorities will be optimally choosing m or f and m^* or f^* respectively in either a cooperative or uncooperative fashion. These choices will take cognizance of the shocks, and on the assumption of an unchanged regime in the future, a time-consistent solution will imply that the expected value of all real variables will be constant through time, while nominal variables will inflate at a constant expected rate reflecting the underlying rate of monetary growth. This means that static expectations of changes will be rational.

We shall simplify notation by assuming that all nominal variables had a value of 0 in the period prior to the one being analyzed; being in logarithms, the following solutions can then be interpreted as growth rates. From the above, it follows that a time-consistent solution will give:

$$E\pi_{+} = E\pi = EP - P_{-} = EP = Ep = \overline{w} \qquad (10a)$$
$$Ee_{+} - e = E\pi - E\pi^{*} = EP - EP^{*} = \overline{w} - \overline{w}^{*} \qquad (10b)$$
$$Ey = E\varepsilon = E\varepsilon = 0 \qquad (10c)$$
$$Ei = E\pi = EP = \overline{w} \qquad (10d)$$
$$Em = (1-\lambda)EP = (1-\lambda)\overline{w} \qquad (10e)$$

Note that (10b) implies that real interest rates are equalised *ex post*, while (10d) says that their *ex ante* values are zero. (10c) indicates that outputs and the real and nominal exchange rate are expected to be zero in the symmetrical equilibrium - unexpected (contingent) monetary or fiscal shocks can upset these expectations.

The algebra required to solve the model is extremely tedious and only the procedure will be indicated. To begin, explicit solutions for the key endogenous variables are given and key features noted. Then monetary and fiscal transmission mechanisms will be discussed bringing out the intuition behind the complicated reduced forms and comparing the outcomes for the four sub-models.

The solution is linear and can be obtained by adding and subtracting the home equations ((6), (7) and (9)) and their symmetrical foreign equivalents. Expressions for added (and subtracted) outputs are obtained from the added (subtracted) set of the resulting equations, and these can then be solved for y and y^* in terms of the money and fiscal instruments and base wages. Substituting back into the system, one can then obtain the reduced form solutions for the exchange rate and domestic and foreign prices, and interest rates. We are particularly interested in the solutions for outputs and prices as these will be needed in Section 3.

Following the suggested sequence of steps, we obtain the following linear expressions for output in the two countries:

Outputs

$$y = M_y \tilde{m} + M_y^{*} \tilde{m}^{*} + \Gamma_y f + \Gamma_y^{*} f^{*} + U_y \qquad (11)$$
$$y^{*} = M_y \tilde{m}^{*} + M_y^{*} \tilde{m} + \Gamma_y f^{*} + \Gamma_y^{*} f + U_y \qquad (11^{*})$$

where[3]

$$\tilde{m} = m - (1-\lambda)\overline{w} = m - Em \qquad (11a)$$
$$\tilde{m}^{*} = m^{*} - (1-\lambda)\overline{w}^{*} = m^{*} - Em^{*} \qquad (11b)$$
$$M_y = \tfrac{1}{2}\left[\frac{1}{A_1} + \frac{1}{A_2}\right] > 0 \qquad (11c)$$
$$M_y^{*} = \tfrac{1}{2}\left[\frac{1}{A_1} - \frac{1}{A_2}\right] \gtrless 0 \qquad (11d)$$
$$\Gamma_y = \tfrac{1}{2}\gamma\left[\frac{\lambda}{\sigma A_1} + \frac{(1-\alpha)}{\delta(1-\beta)A_2}\right] > 0 \qquad (11e)$$
$$\Gamma_y^{*} = \tfrac{1}{2}\gamma\left[\frac{\lambda}{\sigma A_1} - \frac{(1-\alpha)}{\delta(1-\beta)A_2}\right] \gtrless 0 \qquad (11f)$$
$$A_1 = \phi + \frac{(1-\psi)\lambda}{\sigma} + \frac{1}{\theta(1-\beta)} > 0 \qquad (11g)$$
$$A_2 = \phi + \frac{(1-\alpha)(1+\psi)/\delta + 1/\theta}{(1-\beta)} > 0 \qquad (11h)$$
$$U_y = \left[\frac{u_s}{\theta(1-\beta)} + \frac{\lambda u_d}{\sigma} - u_m\right] / A_1 \qquad (11i)$$

The presence of $\tilde{m}$ and $\tilde{m}^*$ in (11) arises because an increase in the money supply is neutral if the contract wage rises also but by a greater amount just sufficient that real balances fall because of the effects of the implied higher inflation on demand i.e. neutrality is achieved only if the money shock is accompanied by a $(1-\lambda)$ increase in the base wage. An alternative way of interpreting $\tilde{m}$ and $\tilde{m}^*$ comes from observing (10e) and (5); in fact they are (m-Em) and (m^*-Em^*) respectively i.e. unanticipated money shocks. In the time-consistent rational expectation equilibrium of an international monetary game, the authorities will not try to systematically fool the private sector and so $\tilde{m}$ and $\tilde{m}^*$ will on average be zero.

We note that $M_y+M_y^*=1/A_1 \geq 0$ and $M_y-M_y^*=1/A_2 \geq 0$ and that $\Gamma_y-\Gamma_y^* = \gamma(1-\alpha)/(\delta(1-\beta)A_2) \geq 0$ and $\Gamma_y+\Gamma_y^*=\gamma\lambda/\sigma A_1 \geq 0$. These facts will be useful in Section 3.

Having the reduced forms for outputs, the real exchange rate solution follows from the subtracted goods market equations of the two countries. Thus:

Real Exchange Rate

$$\varepsilon = M_\varepsilon(\tilde{m} - \tilde{m}^{*}) + \Gamma_\varepsilon(f - f^{*}) \qquad (12)$$

where

$$M_\varepsilon = \frac{(1+\psi)}{2\delta A_2} \geq 0 \qquad (12a)$$
$$\Gamma_\varepsilon = \frac{-\tfrac{1}{2}\gamma(1 + \theta\phi(1-\beta))}{\delta\theta(1-\beta)A_2} < 0 \qquad (12b)$$

From (12) we see that money, base wage and fiscal shocks from the two countries have mirrored effects on the real exchange rate, something that we should expect of a relative price of goods from perfectly symmetrical countries. The exchange rate is seen to be non-stochastic except insofar as the policy variables have a contingent element, a feature due to perfect symmetry and the perfect international correlation of shocks. It emphasises further the not so well-known point that the exchange rate should never be modelled with idiosyncratic risk unless it is being managed by the policy authorities on the basis of a mixed strategy.

We can observe that $A_2 \rightarrow \infty$ as $\beta \rightarrow 1$ or $\theta \rightarrow 0$ (see (11f)), which implies from (12a) that money cannot affect the real exchange rate under RWR and C. With NWR, monetary expansion generates a real depreciation. Finally, domestic fiscal expansion will cause a real appreciation in all of our models, which is what one would expect in a Mundell-Fleming paradigm. [4]

The added and subtracted money market equations give two expressions for p and p^* in terms of outputs, money stocks, base wages and the real exchange rate. These can be reduced using (11) and (12) and (4) to give:

Local Prices

$$p = \bar{w} + M_p \bar{m} + M_p^* \bar{m}^* + \Gamma_p f + \Gamma_p^* f^* + U_p \quad (13)$$

$$p^* = \bar{w}^* + M_p \bar{m}^* + M_p^* \bar{m} + \Gamma_p f^* + \Gamma_p^* f + U_p \quad (13^*)$$

where

$$M_p = \left[M_y/\theta + \frac{\beta(1-\alpha)(1+\psi)}{2\delta A_2} \right] /(1-\beta) \qquad \geqslant 0 \quad (13a)$$

$$M_p^* = \left[M_y^*/\theta - \frac{\beta(1-\alpha)(1+\psi)}{2\delta A_2} \right] /(1-\beta) \qquad \geqslant 0 \quad (13b)$$

$$\Gamma_p = \tfrac{1}{2} \frac{y}{\theta(1-\beta)} \left[\frac{\lambda}{\sigma A_1} + \frac{(1-\alpha)(1-\phi\theta\beta)}{\delta A_2} \right] \qquad \gtrless 0 \quad (13c)$$

$$\Gamma_p^* = \tfrac{1}{2} \frac{y}{\theta(1-\beta)} \left[\frac{\lambda}{\sigma A_1} - \frac{(1-\alpha)(1-\phi\theta\beta)}{\delta A_2} \right] \qquad \gtrless 0 \quad (13d)$$

$$U_p = \frac{1}{\theta(1-\beta)A_1} \left[\frac{\lambda u_d}{\sigma} - \left(\phi + \frac{\lambda}{\sigma}(1\otimes-\psi)\right) u_s - u_m \right] \quad (13e)$$

From (12), (13) and (4) the price indices become:

Price Indices

$$P = \bar{w} + M_P \bar{m} + M_P^* \bar{m}^* + \Gamma_P f + \Gamma_P^* f^* + U_P \quad (14)$$

$$P^* = \bar{w}^* + M_p \bar{m}^* + M_P^* \bar{m} + \Gamma_P f^* + \Gamma_P^* f + U_P \quad (14^*)$$

where

$$M_P = \left[M_y/\theta + \frac{(1-\alpha)(1+\psi)}{2\delta A_2} \right] /(1-\beta) \qquad > 0 \quad (14a)$$

$$M_P^* = \left[M_y^*/\theta - \frac{(1-\alpha)(1+\psi)}{2\delta A_2} \right] /(1-\beta) \qquad > 0 \quad (14b)$$

$$\Gamma_P = \Gamma_p + (1-\alpha)\Gamma_E$$

$$= \tfrac{1}{2} \frac{y}{\theta(1-\beta)} \left[\frac{\lambda}{\sigma A_1} - \frac{(1-\alpha)\phi\theta}{\delta A_2} \right] \qquad \gtrless 0 \quad (14c)$$

$$\Gamma_P^* = \tfrac{1}{2} \frac{y}{\theta(1-\beta)} \left[\frac{\lambda}{\sigma A_1} + \frac{(1-\alpha)\phi\theta}{\delta A_2} \right] \qquad > 0 \quad (14d)$$

$$U_P = U_p \quad (14e)$$

From (13) and (14), we can deduce that domestic monetary expansion is inflationary at home but not necessarily abroad. But for fiscal policy we get the opposite result. Fiscal shocks need not be inflationary at home and domestic deflation becomes more likely as θ increases in size. In fact, it will be seen in the next section that a negative sign for Γ_P is of great importance in establishing that fiscal policy cooperation is productive. We observe the somewhat surprising result that domestic fiscal expansion will raise foreign inflation in all of our models.

We note for use in the Section 3 that $M_P+M_P^* = (M_y+M_y^*)/\theta(1-\beta)>0$, $M_P-M_P^* = (1-\alpha)(1+\psi)/\delta(1-\beta)A_2>0$ while $\Gamma_P+\Gamma_P^* = y\lambda/[\theta(1-\beta)\sigma A_1]>0$ and $\Gamma_P-\Gamma_P^* = -y(1-\alpha)\phi/[\delta(1-\beta)A_2] < 0$.

Knowing (12) and (13), the nominal exchange rate immediately follows as:

Nominal Exchange Rate

$$e = (\bar{w}-\bar{w}^*) + M_e(\bar{m} - \bar{m}^*) + \Gamma_e(f - f^*) \quad (15)$$

where

$$M_e = \frac{\delta/\theta + (1+\psi)[\beta(1-\alpha) + \tfrac{1}{2}(1-\beta)]}{\delta(1-\beta)A_2} \qquad > 0 \quad (15a)$$

$$\Gamma_e = -\tfrac{1}{2} y \, \frac{(2\alpha-1)(1-\phi\theta\beta) + \phi\theta}{\delta(1-\beta)A_2} \qquad \gtrless 0 \quad (15b)$$

Just like the real, the nominal exchange rate does not depend directly upon the elemental shocks but simply upon the money, wage and fiscal differentials. A domestic monetary expansion depreciates the exchange rate. The fiscal effect is seen to be ambiguous, although an expansion will lead to an appreciation for a sufficiently (and not unreasonably) large value of θ.

From (10b) we already know that real interest equalisation will occur in this model's equilibrium. The solution for real interest rates can be found by adding the domestic and foreign goods demand equations (7) and the implied (7^*), substituting in (11) and (11^*) to give:

Real Interest Rates

$$i - E\pi_{+} = i - \overline{w} = i^* - \overline{w}^* = M_r(\bar{m} + \bar{m}^*) + \Gamma_r(f + f^*) + U_r \qquad (16)$$

where

$$M_r = -\frac{(1-\psi)}{2\sigma A_1} < 0 \qquad (16a)$$

$$\Gamma_r = \frac{1}{2}\frac{y}{\sigma}\left[1 - \frac{1-\psi}{\sigma A_1}\right] \lessgtr 0 \qquad (16b)$$

$$U_r = \frac{1}{\sigma}\left[u_d - (1-\psi)U_y\right] \qquad (16c)$$

After checking the definition of A_1 in (11g), it becomes apparent that positive money shocks in either country will reduce real and nominal interest rates when $\beta<1$, and have no effect when $\beta=1$ or $\theta=0$. Fiscal expansion in either country will raise interest rates when A_1 is large i.e. when $\beta=1$ (RWR) or $\theta=0$ (C) or under NWR and K with sufficiently large σ.

In the next two subsections, an explanation is given for the effects of monetary and fiscal policies on outputs and prices.

2.2 *Monetary Transmission to Outputs and Prices*

From (11) it can be seen that domestic monetary expansion or base wage contraction will lead to negative output transmission abroad if $M_y^*>0$ which occurs if $A_1>A_2$ or if:

$$\beta < 1 - \frac{\sigma(1+\psi)(1-\alpha)}{(1-\psi)\lambda\delta} \qquad (17)$$

The elasticity of supply θ is seen to be irrelevant except insofar as a zero value (as in the C model) would mean stationary outputs and thus no transmission. Thus the K model ($\beta=0$ and $\theta\to\infty$) or the NWR model may have negative transmission.

However, as indexation approaches perfection ($\beta\to1$), negative transmission becomes impossible. From (6) with $\beta=1$, it can be seen that this is because the actual real wage is then simply dependent on the real exchange rate shock and for the foreign country any unexpected real appreciation reduces the real wage and encourages output. Unfortunately, a home real depreciation would then have to be be registered and so home output should fall! But this is impossible since $M_y \geq 0$ and thus we conclude that $M_y=M_y^*=0$. It follows then, from the goods demand equation (7), that the expected real interest rate must be unchanged. Summarising the above, we can state:

<u>Proposition 1</u> *The real exchange rate, real interest rates and both outputs are immune to monetary shocks when real wages are rigid or outputs exogenous.*

If real wages are not rigid, negative transmission is assured if aggregate demand is interest inelastic ($\sigma=0$) - see (17). The intuition for this is that the foreign appreciation makes the foreign country uncompetitive but the real interest effect is unable to compensate. It can compensate if $\sigma>0$ because monetary expansion lowers domestic and foreign real interest rates thereby encouraging both outputs. Remembering that the real rate is $i^*-\bar{w}^*$, the foreign appreciation creates excess foreign money demand (by the factor $(1-\alpha)$) which is cleared by a reduction in the foreign real interest rate (by an enhanced amount with a smaller interest elasticity of money demand λ) and leading to a positive effect on output (depending on the size of σ). The appreciation reduces demand for foreign goods putting downward pressure on its price thus worsening the product wage and output (depending on $(1-\beta)$). Thus as the price elasticity of demand δ gets bigger, a positive domestic monetary shock that appreciates the foreign exchange rate is more likely to worsen foreign output. We also know that domestic output benefits when the real interest rate falls and when a domestic depreciation is registered, and this leads to a direct increase in y^* via ψ.

We can now state:

<u>Proposition 2</u> *If real wages are not rigid, endogenous domestic output is improved by domestic monetary expansion, while foreign output may be.*

Local monetary increases are always locally inflationary. In the C and RWR models, this elasticity is unity reflecting unit elasticities on the domestic product price and on the nominal exchange rate. Moving to the NWR model and then to the K one, the elasticity (M_p) declines which is simply because domestic output also rises thus taking some of the heat out of inflation.

Domestic money shocks may lead to foreign deflation if there is a positive transmission of output - this is because the possibly higher foreign output raises money demand requiring a lower price index. The inflation transmission abroad of money (and wage) shocks is ambiguous in general. The four cases will be considered in turn. Under RWR and C, (14a) and (14b) become

$$M_p = M_p = 1$$
$$M_p^* = M_p^* = 0$$

This means that any national monetary growth will not generate inflation worldwide under flexible exchange rates if real wages are rigid or the model is classical in nature. Flexible exchange rates do insulate national economies from foreign money money growth if wages are fully indexed. The intuition behind this familiar result is that domestic money growth leads to a foreign nominal exchange rate appreciation which exactly cancels with the domestic goods price inflation creating no effects on the foreign money market. Since we already know that the real exchange rate and the real interest rate are not engaged by monetary shocks (with perfect wage indexation), local monetary shocks can only have local effects.

Now considering NWR, the foreign real exchange rate and the real interest rate will fall unexpectedly. Looking at the foreign goods demand - implicitly (7^*), we cannot then tell what happens to output, and thus from the foreign supply equation - (6^*), we cannot be sure whether p^* should rise or fall. While we know that the foreign real exchange rate appreciates, the ambiguous p^* effect means that we cannot be sure what will happen to the foreign price index. From (13b) and (14b), we see that NWR can deliver insulation (i.e. M_p=0) but with probability of measure zero.

Finally, in the K model, product prices are fixed and so inflation outcomes simply depend on the exchange rate. Since a home depreciation occurs, home inflation and thus foreign deflation must result.

Proposition 3 *Flexible exchange rates do not insulate domestic inflation from foreign monetary inflation except when real wages are rigid or outputs exogenous. Foreign deflation may occur when only nominal wages are rigid and will in the Keynesian model.*

From (15), we can observe that an unexpected increase in domestic monetary growth leads to an immediate depreciation of the nominal exchange rate. Comparing this to the solution for the expected (future) depreciation, $Ee_{+}-e = (\bar{w} - \bar{w}^*)$ given in (10b), and (14), we see that unexpected monetary shocks raise current depreciation above future expected depreciation. This is a result one would expect from a transitory shock.

2.3 *Fiscal Transmission to Outputs and Prices*

From (11) fiscal expansion at home will raise home output with an implied 'multiplier' which will be greatest in the K fixprice model (when $\theta \to \infty$). In a small country model, with α=1, Mundell established the fiscal policy ineffectiveness proposition under flexible exchange rates. Branson and Buiter (1983) showed that this result depended on the assumption that α=1. However it does not hold in the two country model, even if α=1, because world interest rates actually change after the fiscal expansion. Fiscal policy will be neutral in one peculiar situation - that is when money demand is interest inelastic (λ=0) and only local goods are consumed (α=1). Fiscal policy simply crowds out investment and exports because nominal (and thus real) interest rates rise while the exchange rate appreciates. Nothing else is affected and so we have a two-country analogue of the Mundellian fiscal policy ineffectiveness proposition under flexible exchange rates, albeit with a restricted set of coefficient values.

When β=1 or θ=0, it is immediately apparent that $A_1 \to \infty$ and so $\Gamma_y = -\Gamma_y^* = \frac{1}{2}\gamma\theta(1-\alpha)/(\delta+\theta(1+\psi)(1-\alpha))<1$. Hence for RWR, unilateral fiscal policy is a zero-sum game with the home country gaining at the expense of the other. From the supply side, the mechanism can only be via the real exchange rate (see (6)with β=1)), and evidently a home real appreciation must occur. On the foreign demand side, the fall in demand is brought about by a higher real interest rate. In the C model, fiscal policy is a trivial zero-sum game because outputs are exogenous.

However with the NWR and K models, a positive game emerges and it is possible that domestic fiscal expansion can also create real foreign benefits. Now real interest rates do not have to rise by as much as when β=1, and so knowing that the foreign real exchange rate must depreciate, a foreign output gain is conceivable. From the foreign supply side, the higher output is made possible because home fiscal policy causes inflation of foreign prices. Clearly this game is only transitory because in subsequent periods real outputs resume their natural rate values.

Hence:

<u>Proposition 4</u> *Fiscal policy is a zero-sum international game if real wages are rigid or output exogenous. With nominal wage stickiness or rigidity, it is a positive-sum game in which both parties could benefit.*

With regard to the inflation implications of fiscal policy, the simplest case to deal with is the K one. Since this is a fixprice paradigm, inflation transmission is only associated with movements in the nominal (and real) exchange rate. Clearly domestic inflation shocks are reflected by foreign deflation ones. Domestic fiscal expansion leads to a domestic real appreciation, directly causing domestic deflation and foreign inflation.

For the extreme RWR model, we know from proposition 5 that foreign output will fall after a home fiscal expansion. We also know from (16) that real and nominal interest rates rise worldwide. Thus focussing on the foreign money market equilibrium condition - implicitly (9^*) - real foreign demand for money will have fallen which requires a higher foreign price index to restore equilibrium. However home inflation need not be kindled because home output may rise by enough to pre-empt a need for higher domestic prices to clear the domestic money market.

At the other extreme is the C model. Here $\Gamma_p=\Gamma_p^*=\frac{1}{2}\gamma\lambda/\sigma>0$. and so fiscal expansion creates identical inflation worldwide. This is because worldwide interest rates go up by $\frac{1}{2}\gamma/\sigma$, thus lowering worldwide money demand via λ, necessitating price index inflation everywhere to clear the money market. Since the domestic real exchange rate appreciates it must be true that the domestic product price rises, while the foreign product price may go either way.

For the inbetween model of NWR, there is positive inflation transmission abroad of domestic fiscal expansion, despite the fact, as mentioned two paragraphs back, real interest rates do not have to move up so much (possibly even falling) and that foreign output may even rise. By contrast, domestic inflation is ambiguously affected because while p may need to rise to help bring about higher domestic output supply, the real exchange rate appreciates. The bigger the supply elasticity, θ, the more possible that the domestic product price (p) can fall, ensuring home deflation (of P) after a domestic fiscal expansion. This parameter will play a crucial role for establishing productive fiscal cooperation.

In summary then:

<u>Proposition 5</u> *A domestic fiscal expansion will always cause foreign inflation. In the Keynesian model, domestic and foreign inflation are oppositely affected. In the Classical model the inflation effects are identical worldwide. In the rigid nominal and real wage models, the domestic inflation effects are ambiguous, though inflation will occur for sufficiently large θ.*

<u>SECTION 3</u> Optimal Policy Analysis

In this two country model, there are four policy instruments available to the two governments. If each set themselves two independent, unshared targets, they could achieve their aims precisely - this is nothing but the Tinbergen rule for policy. Of course, if the number of targets exceed independent instruments or if there are shared targets, then target trade-offs exist and international policy-making becomes a game between the participating governments.

We shall assume that each government chooses to assign one of its instruments to addressing two related targets, with the other instrument dealing with another dependent target. In the first instance, fiscal policies are held neutral and monetary policies are used to minimise a quadratic loss function involving inflation and output. Then we reverse the policy roles and consider the question of fiscal policy cooperation assuming a passive neutral role for monetary policy.

3.1 *International Monetary Policy Cooperation*

Let us assume that fiscal policy instruments are set exogenously to zero - indeed, this would be the policy that would support an equilibrium in which output meets the wage-setters target, $\bar{y}=0$. In this sense, fiscal policy is a neutral element in the monetary game.

Each government selects a money supply policy which minimises an expected quadratic loss function involving output and inflation. For the home country, the minimised loss is:

$$\text{Loss} = \min_{\bar{m}} \left[(y-\hat{y})^2 + \Omega(\pi-\hat{\pi})^2 \right]$$

where $\hat{y}$ and $\hat{\pi}$ are the two target values. For the foreign country, there is a similar loss function with identical target values. Remembering the discussion about (10) above, the inflation gap in the loss function, $(\pi-\hat{\pi})$, can be represented as $(P-\hat{P})$ without any loss of generality.

The optimal policy will comprise a systematic and a shock-contingent element. The governments, though not wage-setters, are able to respond optimally to realized demand and supply shocks, and in a rational expectations solution, the state contingent element, U_m for the home government, will follow a stochastic process that optimally compensates for the fundamental shocks, which in this model implies a mean of zero. Fortunately, the systematic and the state-contingent elements of policy can be determined separately in the present analysis. This means that the total loss can be broken down into a systematic component, L, and a 'contingent' component, l. Thus:

$$\hat{m} = E\hat{m} + U_m \tag{19}$$

$$\text{Loss} = L + l \tag{20}$$

We shall analyse systematic policy first, followed by contingent policy.

The governments of the two countries can choose to act uncooperatively or to cooperate. We begin with the former and examine the resulting Nash solution assuming that wage setters expect this solution. This is then compared with the cooperative one in which wage-setters expect that. As mentioned in the Introduction, no matter how wage-setters fix their wage, the policy authorities will then always find it optimal to cooperate *ex-post* - this is the only sub-game perfect equilibrium as shown by Carraro and Giavazzi (1988) and explained in the Introduction. By making our comparison, we are able to pronounce on the *ex-ante* Pareto optimality of the cooperative equilibrium.

3.1.1 *Optimal Systematic Monetary Policy*

The systematic loss component is simply

$$L = \min_{E\hat{m}} E[(y-\hat{y})^2 + \Omega(\pi-\hat{\pi})^2] \tag{21}$$

In a Nash solution, each party to the game ignores the repercussions of his/her own actions on the other parties. Thus inserting the reduced form solutions for y (from (11)) and P (from (14)) in (21), the first order conditions for a minimum in the two countries are:

$$E\hat{m} = \theta_0 E\hat{m}^* + \theta_1 \tag{22}$$

$$E\hat{m}^* = \theta_0 E\hat{m} + \theta_1 \tag{22*}$$

where

$$\theta_0 = \frac{-(M_y M_y^* + \Omega M_P M_P^*)}{M_y^2 + \Omega M_P^2} \tag{22a}$$

$$\theta_1 = \frac{M_y \hat{y} - \Omega M_P(\bar{w}-\hat{p})}{M_y^2 + \Omega M_P^2} \tag{22b}$$

The sign of θ_0 is crucial for the slope of the reaction functions. Note that $|\theta_0|<1$ because $M_y>M_y^*$ and $M_P>M_P^*$ as pointed out below (11). However we cannot sign θ_0 in general because the transmission of money shocks to foreign output and inflation depends on the underlying model. In the RWR and C regimes, from propositions 1 and 3, we know that M_y^* and M_P^* are both zero, and so domestic monetary policy is selected in complete disregard for foreign monetary policy. From (17) and proposition 2, we know that M_y^* is more likely to be negative as we move from the extreme RWR and C models, through the NWR ones, to the K model. From proposition 3, we know that $M_P^*<0$ in the K model, but is ambiguous in the NWR one.

The Nash solution values for money and base wages can now be easily obtained. The solution has to obey rational expectations and the private sector is assumed to be fully informed about the governments' loss functions and their type of behaviour in the game. Thus the government cannot and will not attempt to fool the private sector on a systematic basis which means that expected policy shocks must be zero (cf (11a) and (11b)):

$$E\hat{m} = E\hat{m}^* = 0$$

However the only way that this can be true with the reaction functions (22) and (22*) is if $\theta_1=0$, which provides us with the Nash solution for the base wage, $\bar{w}^N$ (from (22b)). Thus:

$$\bar{w}^N \,(=\bar{w}^{*N}) = EP^N \,(=EP^{*N}) = \hat{P} + \frac{M_y}{\Omega M_P}\hat{y} = \frac{Em^N}{(1-\lambda)} \tag{23}$$

Since we know that y^N is zero, the minimised systematic loss under Nash is simply:

$$L^N = \left[1 + \left(\frac{M_y}{\Omega M_P}\right)^2\right]\hat{y}^2 + \text{var}(y) + \Omega\text{var}(P) > 0 \tag{24}$$

There are two interesting features about this solution. First, from (23), we see that, if $y^N=\bar{y}=0$, then any targetted value of output in excess of that value will necessitate higher inflation. But if the monetary authorities and wage-setters happened to agree on the output target, the inflation target will be met exactly. In this event, international cooperation will be an irrelevancy. Thus the question of cooperation or otherwise depends on internal disagreement in each country. This means that we should expect unusual results because there are two subsidiary games taking place between wage setters and the governments which are not being resolved cooperatively. Second, L^N reaches its minimum in the RWR and C models - this follows from (24) using proposition 1.

Now consider the cooperative equilibrium. The two monetary authorities jointly select m and m^* to minimise the sum of their loss functions. The resulting first order conditions for systematic policy are identical because the economies are symmetrical, and so taking either we get:

$$E\hat{m}^C = E\hat{m}^{*C} = \frac{(M_y-M_y^*)\hat{y} - \Omega(M_P-M_P^*)(\bar{w}^C - \hat{P})}{(M_y^2-M_y^{*2}) + (M_P^2-M_P^{*2})} \tag{25}$$

Once again rational expectations tell us that monetary policy shocks must be zero on average in equilibrium i.e. the numerator in (25) has to be zero. Thus:

$$\bar{w}^C\ (= \bar{w}^{*C}) = EP^C\ (= EP^{*C}) = \hat{P} + \frac{(M_y-M_y^*)\hat{y}}{\Omega(M_P-M_P^*)} = \frac{Em^C}{1-\lambda} \tag{26}$$

and the expected systematic loss becomes:

$$L^C = \left[1 + \frac{(M_y-M_y^*)^2}{\Omega(M_P-M_P^*)^2}\right]\hat{y}^2 + var(y) + \Omega var(P) > 0 \tag{27}$$

This cooperative equilibrium is located on the world's policy contract curve (which is the locus of points where the home and foreign marginal rates of substitution of Em and Em^* are equalised) at the particular point for which the expected nominal exchange rate is zero.

Comparing (27) to (24), we see that the systematic cooperative equilibrium is superior to the uncooperative one ($L^C<L^N$) if

$$\frac{(M_y-M_y^*)^2}{(M_P-M_P^*)^2} - \frac{M_y^2}{M_P^2} < 0$$

or using the definitions in (11) and (14), if the following is negative:

$$M_yM_P^* - M_y^*M_P = \frac{-(1-\alpha)(1+\psi)(M_y+M_y^*)}{2\delta A_2(1-\beta)} \tag{28}$$

Clearly this cannot be negative. Of course it will be zero in the RWR and C models because $M_y=M_y^*=0$. Thus we have reproduced the Rogoff (1985) result for systematic international monetary policies which is:

<u>Proposition 6</u> *Systematic international monetary cooperation is counter-productive in nominal wage resistance and fixprice Keynesian models provided governments and wage setters cannot agree on output targets. For a rigid real wage or a classical exogenous output model, systematic international monetary cooperation is an irrelevancy.*

The reason for the counter-productive result in the NWR and C models is that cooperation leads to a higher deviation (±) of the equilibrium price index from target - this follows from subtracting (23) from (26) with the resulting difference being dependent upon $M_yM_P^*-M_y^*M_P$ which we know from (28) to be positive. The output gap is the same for the two policy regimes but the price gap is smaller under Nash.

However the expected rate of inflation may be higher or lower under the cooperative regime depending on whether the government's (logarithmic) output target is greater or less[3] than the wage setter's output target (i.e. $EP^C \gtrless P^N$ when $\hat{y} \gtrless \bar{y}=0$). In the former case, the home government could always do better if cooperation were forbidden *ex-ante*. It could lower its money supply, leading to an exchange rate appreciation and lower prices and a better trade-off between the inflation and output gaps. The foreign country would suffer depreciation and thus would perceive higher inflation and an even worse inflation gap. It would choose to retaliate and cut its money supply. This process continues with competitive appreciations until the (constrained) Nash equilibrium is attained. Instead if the cooperative regime had a lower rate of equilibrium expected inflation, competitive depreciations will result until the Nash equilibrium is realized.

<u>Proposition 7</u> *Cooperative monetary regimes will be associated with higher (lower) inflation than uncooperative ones if the government has a greater (smaller) output target than wage setters and prohibited cooperative equilibrium will degenerate in a series of competitive appreciations (depreciations).*

We now turn to optimal monetary responses to unexpected shocks in the economies.

3.1.2 *Optimal Contingent Monetary Policy*

The component l of the total loss involves only those terms concerning realised shocks and shock-contingent policy i.e. for the home country

$$l = \min_{U_m} [M_y U_m + M_y^* U_m^* + U_y]^2 + \Omega [M_p U_m + M_p^* U_m^* + U_p]^2 \qquad (29)$$

Given perfect symmetry, the optimal responses in the two countries will be identical. The Nash solution for these is easily computed as

$$U_m^N = \frac{-(M_y U_y + \Omega M_p U_p)}{M_y(M_y + M_y^*) + \Omega M_p(M_p + M_p^*)} \qquad (30)$$

and the expected minimum contingent loss is

$$El^N = \frac{\Omega (M_y^2 + \Omega M_p^2) E[(M_y + M_y^*)U_p - (M_p + M_p^*)U_y]^2}{[M_y(M_y + M_y^*) + \Omega M_p(M_p + M_p^*)]^2} > 0 \qquad (31)$$

We can observe that it is optimal to tighten monetary policy whenever there are positive output or inflation shocks.

The cooperative solutions for contingent monetary policy and the associated expected minimum loss are

$$U_m^C = \frac{-[(M_y + M_y^*)U_y + \Omega(M_p + M_p^*)U_p]}{(M_y + M_y^*)^2 + \Omega(M_p + M_p^*)^2} \qquad (32)$$

$$El^C = \frac{\Omega \; E[(M_y + M_y^*)U_p - (M_p + M_p^*)U_y]^2}{(M_y + M_y^*)^2 + \Omega(M_p + M_p^*)^2} > 0 \qquad (33)$$

Once again monetary policy is tightened when there are positive output and price shocks. Comparing (30) and (32) and using (28), we conclude that the Nash response is more vigorous to output shocks, but less vigorous to inflation shocks.

The comparison of the contingent loss for the Nash and the cooperative games turns out to be totally different to the systematic loss comparison. Subtracting (31) from (33) gives

$$El^C \leq El^N$$

with strict inequality for all but the RWR and C models.

Thus:

<u>Proposition 8</u> *Cooperation is productive with regard to optimal contingent monetary policy, except when real wages are rigid or outputs are exogenous.*

Taking Proposition 8 in conjunction with Proposition 6, it is apparent that there are opposing forces in the debate about whether there should be international monetary cooperation. Clearly, the greater the variance of the fundamental supply and demand shocks, the more likely that there will be net benefits from cooperation. This makes good intuitive sense because the shocks have been assumed to be transitory in nature, and so it makes good sense to establish a cooperative response to minimise their effects.

3.2 *International Fiscal Policy Cooperation*

In this subsection the two governments have active fiscal policies and passively neutral monetary policy. The neutrality of nominal money across fiscal policy regimes is necessary if we are to focus on fiscal policy issues alone. Neutrality is ensured (as mentioned below (11) if money is endogenously set as:

$$m = (1-\lambda)\,\bar{w}$$
$$m^* = (1-\lambda)\,\bar{w}^* \qquad (34)$$

This means that $\tilde{m}$ and $\tilde{m}^*$ are both always zero and thus that there is no contingent element in the supporting monetary policy.

Once again, we can deal separately with the systematic and the contingent elements of fiscal policy. We shall use the same procedure as in the previous sub-section 3.1, without repeating the method.

3.2.1 *Optimal Systematic Fiscal Policy*

Substituting (11) and (14) into (21) (and implicitly (21*)) and following the same procedure as in the previous section, we get:

$$\bar{w}^N \; (= \bar{w}^{*N}) \;=\; Ep^N \; (= Ep^{*N}) \;=\; \hat{P} \;+\; \frac{\Gamma_y}{\Omega\Gamma_P}\hat{y} \;=\; \frac{m^N}{1-\lambda} \qquad (35)$$

and

$$L^N \;=\; \left[\, 1 + \left(\frac{\Gamma_y}{\Omega\Gamma_P}\right)^2 \right] \hat{y}^2 \;+\; var(y) \;+\; \Omega var(P) \;>\; 0 \qquad (36)$$

In contrast to the international monetary Nash solution, we cannot be sure in general whether a higher government output target will imply higher inflation. This is because Γ_P is indeterminate in the RWR and NWR model, although it is indeed positive in the K model. In the C model where output is exogenous, the Nash and the cooperative solutions are identical and achieve the bliss of zero loss.

The cooperative fiscal equilibrium again mirrors the monetary one in form but not in implication:

$$\bar{w}^C \; (= \bar{w}^{*C}) \;=\; Ep^C \; (= Ep^{*C}) \;=\; \hat{P} \;+\; \frac{(\Gamma_y-\Gamma_y^*)\,\hat{y}}{\Omega(\Gamma_P-\Gamma_P^*)} \;=\; \frac{m^C}{1-\lambda} \qquad (37)$$

with:

$$L^C \;=\; \left[\, 1 + \frac{(\Gamma_y-\Gamma_y^*)^2}{\Omega(\Gamma_P-\Gamma_P^*)^2} \right] \hat{y}^2 \;+\; var(y) \;+\; \Omega var(P) \;>\; 0 \qquad (38)$$

Comparing the expected losses, cooperation is superior if the following expression is negative:

$$\frac{(\Gamma_y-\Gamma_y^*)^2}{(\Gamma_P-\Gamma_P^*)^2} - \frac{\Gamma_y^2}{\Gamma_P^2} = \left[\frac{(\Gamma_y-\Gamma_y^*)}{(\Gamma_P-\Gamma_P^*)} + \frac{\Gamma_y}{\Gamma_P} \right] \left[\frac{(\Gamma_y-\Gamma_y^*)}{(\Gamma_P-\Gamma_P^*)} - \frac{\Gamma_y}{\Gamma_P} \right]$$

$$= \frac{[\,\Gamma_P(\Gamma_y-\Gamma_y^*) + \Gamma_y(\Gamma_P-\Gamma_P^*)\,]\;\{\Gamma_y\Gamma_P^* - \Gamma_y^*\Gamma_P\}}{(\Gamma_P-\Gamma_P^*)^2\;\Gamma_P^2} \qquad (39)$$

The term in braces({..}) in (39) is easily shown to be

$$\{\Gamma_y\Gamma_P^* - \Gamma_y^*\Gamma_P\} \;=\; \frac{y^2\lambda(1-\alpha)(1+\delta\theta\phi(1-\beta))}{2\theta\sigma\delta A_1 A_2(1-\beta)^2} \;\geq 0$$

which is non-negative in general (and 0 in the C model only). Thus the issue turns on the sign of the term in square brackets in (39). Below (11) we mentioned that $\Gamma_y-\Gamma_y^*$ was non-negative, and below (13) that $\Gamma_P-\Gamma_P^*$ was non-positive. Since Γ_y is non-negative, a

sufficient (but not necessary) condition for (39) being negative is that Γ_P is negative. We know from (14c) that this will be the case for sufficiently high values of θ, and/or low values of λ. It would be false if $\phi=0$.

With respect to our four submodels we can say that (39) is zero in the C model (because $\Gamma_y=\Gamma_y^*=0$), negative in the K model (because $\Gamma_P<0$ in that model), and ambiguous in the NWR and RWR models. Thus in contrast to the international monetary cooperation results, irrelevancy of systematic fiscal cooperation applies only in the C model and may be productive or counter-productive in the RWR model. The K model displays polar opposites for fiscal and monetary cooperation.

If Γ_P is negative, we now know that $E(P^C-\hat{P})^2 < E(P^N-\hat{P})^2$; however this does not let us deduce that the cooperative solution involves a lower expected price (inflation) than the Nash one. The proof comes from subtracting (35) from (37) which gives:

$$Ep^C \;=\; Ep^N \;+\; \left[\frac{\Gamma_y\Gamma_P^* - \Gamma_y^*\Gamma_P}{(\Gamma_P-\Gamma_P^*)\,\Gamma_P} \right] \frac{\hat{y}}{\Omega} \qquad (40)$$

The numerator of the term in square brackets is positive (as mentioned below (39)), and $\Gamma_P-\Gamma_P^*<0$, and so the sign of the term simply depends on Γ_P again.

Consider the case where $\Gamma_P<0$ (which we know implies productive cooperation) and let $\hat{y}$ be positive. Then from (37) and (40), $\hat{P} > Ep^C > Ep^N$ and so the Nash solution has the lower inflation.

For the example at hand, if cooperation were to be prohibited, the incentive will be via fiscal expansion which will lead to retaliation of the same form and a series of competitive appreciations until the Nash solution is achieved. The initial increase in f (from 0) will lower P (assuming $\Gamma_P<0$) and raise y towards $\hat{y}$. A real home appreciation results. The foreign government sees real depreciation and higher inflation and thus has an incentive to raise its output closer to $\hat{y}$ given that its inflation gap has improved. This generates a retaliatory appreciation. All the while, wage setters are aware that cooperation does not exist, and that ultimately inflation will be lower and the real exchange rate will be back to zero. Base wages ($\bar{w}$ and $\bar{w}^*$) are set down to the lower product prices (Ep^N and Ep^{*N}) and the money supplies fall to maintain neutrality. f^N and f^{*N} can then return to their natural values, 0.

Proposition 9 *Systematic international fiscal policy cooperation is productive in a fixprice Keynesian model, and is irrelevant in the classical exogenous output model. For the nominal and real wage resistance models, cooperation is productive if the wage elasticity output supply is sufficiently high.*

Proposition 10 *A cooperative fiscal regime will have a higher (lower) rate of inflation than the uncooperative one if fiscal cooperation is productive and the governments' output targets is greater (lower) than wage setters. If cooperation were forbidden, there would be retaliatory fiscal expansions (contractions), initially, leading to competitive appreciations (depreciations), and eventually lower (higher) base wages.*

Proposition 10 provides us with an analogue of Turnovsky (1988)'s result that cooperation will imply a lower level of government spending than Nash. This is true in this model when $\hat{y}>\bar{y}$.

Having established that the systematic aspect of cooperative fiscal policy can be productive, we shall now show that that this is always true for contingent fiscal policy.

3.2.2 *Optimal Contingent Fiscal Policy*

Minimising the contingent loss function, analogous to (29), with respect to the contingent element of iscal policy, U_f (cf. (19)), taking U_f^* as given, we obtain the Nash solution

$$U_f^N = \frac{-(\Gamma_y U_y + \Omega \Gamma_P U_P)}{\Gamma_y(\Gamma_y + \Gamma_y^*) + \Omega \Gamma_P(\Gamma_P + \Gamma_P^*)} \tag{41}$$

and the expected minimum contingent loss is

$$El^N = \frac{\Omega(\Gamma_y^2 + \Omega\Gamma_P^2)\, E[(\Gamma_y + \Gamma_y^*)U_P - (\Gamma_P + \Gamma_P^*)U_y]^2}{[\Gamma_y(\Gamma_y + \Gamma_y^*) + \Omega\Gamma_P(\Gamma_P + \Gamma_P^*)]^2} > 0 \tag{42}$$

In contrast to monetary policy, we observe that the optimal contingent fiscal policy responses under Nash to output or inflation shocks are ambiguous, because we cannot sign Γ_P.

The cooperative solutions for contingent fiscal policy and the associated expected minimum loss are

$$U_f^C = \frac{-[(\Gamma_y + \Gamma_y^*)U_y + \Omega(\Gamma_P + \Gamma_P^*)U_P]}{(\Gamma_y + \Gamma_y^*)^2 + \Omega(\Gamma_P + \Gamma_P^*)^2} \tag{43}$$

$$El^C = \frac{\Omega\, E[(\Gamma_y + \Gamma_y^*)U_P - (\Gamma_P + \Gamma_P^*)U_y]^2}{(\Gamma_y + \Gamma_y^*)^2 + \Omega(\Gamma_P + \Gamma_P^*)^2} \tag{44}$$

With cooperation, we restore the intuitive result that fiscal policy is tightened when there are positive output and price shocks. Comparing (41) and (43), it can be shown that for sufficiently negative Γ_P, the Nash response of fiscal policy is less vigorous to output shocks, but more vigorous to inflation shocks. This case is in sharp contrast to the contingent monetary policy result.

Finally, let us compare the contingent loss for the Nash and the cooperative fiscal policy games. Here we get an identical result with contingent monetary policy i.e.

$$El^C < El^N$$

with strict inequality for all but the C model. In contrast to monetary policy, contingent fiscal policy cooperation does matter in the RWR model.

Summarising then:

Proposition 11 *Contingent fiscal policy cooperation is productive, except when output is exogenous.*

Bringing Propositions 9 and 11 together, we can state that fiscal policy is definitely productive in the K model. It is quite irrelevant in the C model. For the RWR and NWR models, the contingent aspects recommend cooperation, which will be supported on the systematic side when the wage elasticity of output is sufficiently large. Of course, just as with monetary policy, for a world subject to very high variability of shocks so that the contingent benefits dominate, fiscal cooperation will be productive (except in the C model) .

SECTION 4 Concluding Comments

This paper has established that the case for international fiscal cooperation is much stronger than the one for monetary cooperation. This result has been obtained in the context of a perfectly symmetrical two country model. The results would be robust to a change to a model with modestly different country parameters. With large differentials, one should expect different conclusions. For example, with Proposition 9 in mind, if one country had a low θ and the other a very high one, then it would not be clear whether systematic cooperation would benefit either country. Similarly, if international shocks were not perfectly positively correlated, the analysis of contingent cooperation would not be so straightforward.

The lack of cooperation in the real world can be ascribed to the costs of setting-up and monitoring structures. Where cooperation is counterproductive, in the Carraro and Giavazzi (1988) sense, these costs may be sufficient to prevent suboptimal cooperation from taking place. If these costs are not significant, then credible institutions would have to be designed to prohibit such cooperative ventures. For example, the regular IMF Interim Meetings, OECD Group meetings would have to be abandoned.

One interesting avenue of thought, ignored here, is that counterproductivity of cooperation may emerge when there is uncertainty about the underlying macroeconomic model (for example see Frankel and Rockett (1988)). Cooperation based on grossly inappropriate models can easily deliver grievously undesirable results. These results assume irrationality of policy-makers with regard to model uncertainty. A rational approach requires them to utilise information about parameter disributions when constructing their policies - in this way, we would expect a more conservative response, and cooperation should remain productive (for a further discussion, see Ghosh and Masson (1988)).

This paper has stuck with the tradition of considering a world of two countries. Interesting results do emerge when more countries are introduced because coalitions may develop (for example, see Kehoe (1987) and Turnovsky (1988)). Cooperation amongst coalitions may turn out to be counterproductive because we are no longer in the world of first-best. This is reminiscent of the customs union literature on trade creation and trade diversion.

Another important reason why cooperation may not be beneficial is that governments may not know each others' objectives or targets. In a situation of complete ignorance, cooperation must fail because of the impossibility of being assured of the tiuthful revelation of the others' objectives - a classic problem in public goods theory. However, in repeated games, governments are able to learn about the underlying distribution of objectives, and the gains from cooperation will depend on the degree of precision of beliefs about objectives. For example, it is widely accepted that the Bundesbank has a greater dislike of inflation, relative to unemployment, than the Italian, French and British monetary authorities.

FOOTNOTES

1. Government expenditure financed by taxation or bond financing have different effects on the goods market. The fiscal policy variable isa reduced form generated by an unspecified highly complex model of fiscal instruments.

2.These neat properties presume that the random variables are perfectly correlated across the countries - the results would continue to hold on average if instead we merely assumed that they were drawn from identical distributions.

3. Monetary and fiscal elasticities are given explicitly. They are rather complicated and readers not concerned with this detail should merely note the signs. The intuition for these signs is discussed in detail below.

4. If assets were imperect substitutes, and the country was a sufficiently large net debtor, fiscal expansion may lead to a depreciation - see Giavazzi and Sheen(1985).

5. Following Barro and Gordon(1983), Rogoff(1985) argues that the governments' output target will always exceed the natural rate because of tax distortions etc. It is not inconceivable that the governments' target reflects its perception of the natural rate which turns out to be unduly pessimistic.

References

BARRO, R.J. & GORDON, D.B. 'A positive theory of monetary policy in a natural rate model' *Journal of Political Economy*, 91, August, 589-610.

BRANSON, W.H. & BUITER, W.H. (1983) 'Monetary and fiscal policy with flexible exchange rates' in Bhandari, J. & Putnam, B.(eds.) Economic Interdependence and Flexible Exchange Rates MIT Press.

BUITER, W. & MARSTON, R. (1985) International Economic Policy Coordination Cambridge University Press, Cambridge, UK.

CANZONERI, M. & GRAY, J. (1985) 'Monetary policy games and the consequences of non-cooperative behaviour' *International Economic Review*, 26(3), 547-564.

CARRARO, C. & GIAVAZZI, F. (1988) 'Can international policy coordination really be counterproductive' CEPR Discussion Paper No. 258, London.

COOPER, R.N. (1969) 'Macroeconomic adjustment in interdependent economies' *Quarterly Journal of Economics*, 83, February, 1-24.

FRANKEL, J. & ROCKETT, K. (1988) 'Model uncertainty and international policy cooperation' NBER

FRENKEL, J.A. & RAZIN, A. (1986) 'Fiscal policy in the world economy' *Journal of Political Economy*, 94, 564-94.

GHOSH, A.S. & MASSON, P. (1988) 'Policy cooperation under uncertainty??' *IMF Staff Papers*.

GIAVAZZI, F & SHEEN, J.R. (1985) 'Fiscal policy and the real exchange rate' in Currie,D. (ed.) Advances in Monetary Economics Croom Helm, London.

HAMADA, K. (1976) 'A strategic analysis of monetary interdependence' *Journal of Political Economy*, 84, August, 667-700.

KEHOE, P.J. (1987) 'Coordination of fiscal policy in a world economy' *Journal of Monetary Economics*, 19, 349-376.

LUCAS, R.E. & SARGENT, T.J. (1981) Rational Expectations and Econometric Practice George Allen & Unwin, London.

McKIBBIN, W. & SACHS, J. (1986) 'Coordination of monetary and fiscal policies in the OECD' NBER Working Paper No. 1800.

ROGOFF, K. (1985) 'Can international monetary cooperation be counterproductive' *Journal of International Economics*, 18, 199-217.

TAYLOR, J.B. (1985) 'International coordination in the design of macroeconomic policy rules' *European Economic Review*, 28, 53-81.

TURNOVSKY, S.J. (1988) 'The gains from fiscal policy cooperation in the two commodity trade model' *Journal of International Economics*, 25, 111-127.

Working Papers in Economics

84. E.M.A. Gross, W.P. Hogan, I.G. Sharpe	Market Information and Potential Insolvency of Australian Financial Institutions July 1985
85. F. Gill	Over-Award Payments; Result of a Survey conducted in 1982; December 1985
86. S.K. Kim	Short Run Policy Analysis of Employment, Food Price and Rural-Urban Migration for a Labour-Abundant Developing Economy; January 1986
87. E. Kiernan & D.B. Madan	Stochastic Stability in a Rational Expectations Model of a Small Open Economy; March 1986
88. E. Gross	A Note on the Testability of Fama's Efficient Capital Market Hypothesis; February 1986
89. M.C. Blad & E. Gross	Multinational Producers in an Arrow-Debreu Type General Equilibrium Model; March 1987
90. P. Saunders	Explaining International Difference in Public Expenditure: An Empirical Study; August 1986
91. W.P. Hogan	International Debt and Foreign Exchange Markets; January 1987
92. M.C. Blad & N. Oulton	Union-Firm Bargaining as a Repeated Prisoner's Dilemma; January 1987
93. R.T. Ross	The Heckman Procedure for Estimating Static Disaggregate Labour Supply Function: An International Comparison of Estimates for Married Women; March 1987
94. W.P. Hogan	Assessing Insider Trading; June 1987
95. J. Yates	Housing Policy Reform: A Constructive Critique; June 1987
96. B.W. Ross	The Leisure Factor in Entrepreneurial Success during the 'Robber Baron' Era; July 1987
97. F. Gill	Determination of Wage Relativities under the Federal Tribunal: 1953-1974; August 1987
98. A.J. Phipps	Union Objectives, Wage Bargaining and the Phillips Curve; October 1987
99. R.T. Ross	The Labour Market Position of Aboriginal People in New South Wales; November 1987
100. L. Haddad	List Revisited: Dynamic Consideration of Trade and Protection; November 1987
101. J. Piggott	General Equilibrium Computation Applied to Public Sector Issues; December 1987
102. J.A. Carlson & D.W. Findlay	Relative Prices, Wage Indexation and Unemployment; December 1987
103. M. Waterson	A Model of Product Differentiation and Profitability; December 1987
104. P.D. Groenewegen	Taxation and Decentralisation: A Reconsideration of the Costs and Benefits of a Decentralised Tax System; March 1988
105. L. Ermini	Some New Evidence on the Timing of Consumption Decisions and on Their Generating Process; March 1988
106. G. Mills	Spatially-Differentiated Trucking Markets: Equilibria under Price Regulation without Entry Restrictions; April 1988
107. B.W. Ross	Strategic Commitment, Unknowledge and the Nature of Entreprenuerial Activity; April 1988

108.	S.S. Joson	Offsets and Development of Defence Support Industries in Small Economies; April 1988
109.	B.W. Ross	The Conglomerate and the Focussed Agglomerate: Modern Forms of the Leader-Commanded Firm; July 1988
110.	L. Ermini	Inertial Behavior on Schedule and Hierarchical Decomposition; July 1988
111.	L. Ermini	The Limits of Systems Control Theory in Economic Policy-Making; July-October 1988
112.	P.D. Groenewegen	Neo-Classical Value and Distribution Theory: The English Speaking Pioneers; September 1988
113.	V.B. Hall, T.P. Truong & V.A. Nguyen	An Australian Fuel Substitution Tax Model: ORANI-LFT; October 1988
114.	V.B. Hall, T.P. Truong & V.A. Nyuyen	Responses to World Oil and Coal Shocks, in an Australian Short-Run Fuel Substitution Tax Model; October 1988
115.	F. Gill	Social Justice and the Low-Paid Worker; October 1988
116.	G. Kingston	Theoretical Foundations of Constant-Proportion Portfolio Insurance; October 1988
117.	V.B. Hall & D.R. Mills	Is Medium Temperature Solar Thermal Process Steam Viable for Australia? Some Preliminary Results; November 1988
118.	W.P. Hogan	Insider Information and Market Adjustment: November 1988
119.	L. Ermini	Reinterpreting a Recent Temporally Aggregated Consumption-Cap Model; December 1988
120.	P.D. Groenewegen	Progressive Personal Income Tax - A Historical Perspective; December 1988
121.	M.C. Blad & N. Oulton	Rubinstein's Solution of the Bargaining Some Problem: Generalisations and Extensions; December 1988
122.	W.P. Hogan and I.G. Sharpe	Prudential Regulation of Bank Ownership and Control; January 1989
123.	G. Mills	The Reform of Australian Aviation; June 1989
124.	L. Ermini	Transitory Consumption and Measurement Errors in the Permanent Income Hypothesis; June 1989
125.	E. Kiernan	Is Austerity Necessary?; July 1989
126.	F. Gill	Labour Market Flexibility - To What End?; August 1989
127.	E. Kiernan	Financial Reform: A Perspective; September 1989
128.	S. Lahiri & J. Sheen	On Optimal Dumping; September 1989
129.	S. Hargreaves-Heap & Y. Varoufakis	Multiple Reputations in Finitely Repeated Games; October 1989
130.	J. Sheen	International Monetary and Fiscal Policy Cooperation in the Presence of Wage Inflexibilities; October 1989

Copies are available upon request from:

Department of Economics,
The University of Sydney,
N.S.W. 2006, Australia.

Working Papers in Economics Published or Accepted for Publication Elsewhere

2.	I.G. Sharpe & R.G. Walker	Journal of Accounting Research, *13*(2), Autumn 1985
3.	N.V. Lam	Journal of the Developing Economies, *17*(1), March 1979
4.	V.B. Hall & M.L. King	New Zealand Economic Papers, *10*, 1976
5.	A.J. Phipps	Economic Record, *53*(143), September 1977
6.	N.V. Lam	Journal of Development Studies, *14*(1), October 1977
7.	I.G. Sharpe	Australian Journal of Management, April 1976
9.	W.P. Hogan	Economic Papers, 55, The Economic Society of Australia and New Zealand
12.	I.G. Sharpe P.A. Volker	Economic Letters, 2, 1979
13.	I.G. Sharpe & P.A. Volker	Kredit and Kapital, *12*(1), 1979
14.	W.P. Hogan	Some Calculations in Stability and Inflation, A.R. Bergstrom et.al. (eds.), John Wiley and Sons, 1978
15.	F. Gill	Australian Economic Papers, *19*(35), December 1980
18.	I.G. Sharpe	Journal of Banking and Finance, *3*(1), April 1978
21.	R.L. Brown	Australian Journal of Management, *3*(1), April 1978
23.	I.G. Sharpe & P.A. Volker	The Australian Monetary System in the 1970s, M. Porter (ed.), Supplement to the Economic Board 1978
24.	V.B. Hall	Economic Record, *56*(152), March 1980
25.	I.G. Sharpe & P.A. Volker	Australian Journal of Management, October 1979
27.	W.P. Hogan	Malayan Economic Review, *24*(1), April 1979
28.	P. Saunders	Australian Economic Papers, *19*(34), June 1980
29.	W.P. Hogan, I.G. Sharpe & P.A. Volker	Economic Letters, 6 (1980)
29.	W.P. Hogan, I.G. Sharpe & P.A. Volker	Economic Letters, 7 (1981)
30.	W.P. Hogan	Australian Economic Papers, *18*(33), December 1979
32.	R.W. Bailey, V.B. Hall & P.C.B. Phillips	Keynesian Theory, Planning Models, and Quantitative Economics, G. Gandolfo and F. Marzano (eds.), *2*, 703-767, 1987
38.	U.R. Kohli	Australian Economic Papers, *21*(39), December 1982
39.	G. Mills	Journal of the Operational Research Society 33, 1982
41.	U.R. Kohli	Canadian Journal of Economics, *15*(2), No. 2, May 1982
42.	W.J. Merrilees	Applied Economics, *15*, February 1983
43.	P. Saunders	Australian Economic Papers, *20*(37), December 1981
45.	W.J. Merrilees	Canadian Journal of Economics, *15*(3), August 1982
46.	W.J. Merrilees	Journal of Industrial Economics, *31*, March 1983
49.	U.R. Kohli	Review of Economic Studies, *50*(160), January 1983
50.	P. Saunders	Economic Record, *57*(159), December 1981
53.	J. Yates	AFSI, Commissions Studies and Selected Papers, AGPS, IV 1982
54.	J. Yates	Economic Record, *58*(161), June 1982
55.	G. Mills	Seventh Australian Transport Research Forum-Papers, Hobart, 1982

56. V.B. Hall & P. Saunders	Economic Record. *60*(168), March 1984
57. P. Saunders	Economic Record, *59*(166), September 1983
58. F. Gill	Economie Appliquee, *37*(3-4), 1984, pp. 523-541
59. G. Mills & W. Coleman	Journal of Transport Economics and Policy, *16*(3), September 1982
60. J. Yates	Economic Papers, Special Edition, April 1983
61. S.S. Joson	Australian Economic Papers, *24*(44), June 1985
62. R.T. Ross	Australian Quarterly, Vol. 56(3), Spring 1984
63. W.J. Merrilees	Economic Record, *59*(166), September 1983
65. A.J. Phipps	Australian Economic Papers, *22*(41), December 1983
67. V.B. Hall	Economics Letters, 12, 1983
69. V.B. Hall	Energy Economics, *8*(2), April 1986
70. F. Gill	Australian Quarterly, Vol. 59, No. 2, Winter 1987
71. W.J. Merrilees	Australian Economic Papers, *23*(43), December 1984
74. J. Yates	Australian Quarterly, *56*(2), Winter 1984
77. V.B. Hall	Economics Letters, 20, 1986
78. S.S. Joson	Journal of Policy Modeling, *8*(2), Summer 1986
79. R.T. Ross	Economic Record, Vol. 62, No. 178, September 1986
81. R.T. Ross	Australian Bulletin of Labour, *11*(4), September 1985
82. P.D. Groenewegen	History of Political Economy, *20*(4), Winter 1988
84. E.M.A. Gross, W.P. Hogan I.G. Sharpe	Australian Economic Papers, *27*(50), June 1988
94. W.P. Hogan	Company and Securities Law Journal, *6*(1), February 1988
97. F. Gill	Australia's Greatest Asset: Human Resources in the Nineteenth and Twentieth Centuries, D. Pope (ed.), Federation Press, 1988
99. R.T. Ross	Australian Bulletin of Labour, *15*(1), December 1988
100. L. Haddad	Hetsa Bulletin, (11), Winter 1989
101. J. Piggott	Public Sector Economics - A Reader, P. Hare (ed.), Basil Blackwell, 1988
107. B.W. Ross	Prometheus, *6*(2), December 1988
108. S.S. Joson	Rivista Di Diritto Valutario e Di Economia Internazionale, *35*(2), June 1988
116. G. Kingston	Economics Letters, 15 (1989)