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ON OCCASIONAL MONETARY POLICY COORDINATIONS THAT FIX THE EXCHANGE RATE

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Occasionally, central banks have simultaneously expanded monetary policy to prevent adverse effects upon the exchange rate. This paper offers a motivation for this behavior. Although governments prefer non-cooperative policies most of the time, upon viewing sufficiently excessive disturbances to output, the benefits of stabilization become greater than the costs required to institute temporary policy coordinations. Thus, coordination occurs during periods when the gains are the greatest. Also, since the authorities target a higher employment level than labor markets, coordination of policies occurs with greater frequency during periods of low rather than high output shocks.

1. Introduction

In recent years, discussions of coordinated international monetary policy have received renewed emphasis. On occasion, different central banks have agreed to coordinate monetary policy by simultaneously cutting interest rates in order to keep bilateral exchange rates fixed. In April of 1986, for example, the central banks of West Germany, Japan, and the United States coordinated joint interest rate reductions. Other similar events have also occurred infrequently, apparently in response to special circumstances. Thus, despite official rhetoric emphasizing the importance of policy cooperation, governmental authorities appear to continue following non-cooperative policies with only occasional coordination.

This paper offers a motivation for why monetary authorities who usually follow non-cooperative policies may occasionally coordinate monetary policy in order to keep the exchange rate from moving. Due to a conflict between the employment objectives of the authorities and the labor markets, the governments prefer not to enter a binding institutional agreement to fix the

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exchange rate.[1] However, during periods when output disturbances are excessive, the benefits to coordinating policies become large. If the benefits of temporary policy coordinations are large enough, the authorities find the institutional negotiating costs worthwhile. Thus, monetary authorities coordinate policies only during periods when the benefits of stabilizing output exceed the coordinating costs.

This analysis suggests that occasional policy coordination occurs during periods when coordination yields the greatest benefit, a result that contrasts sharply with Canzoneri and Henderson (forthcoming). Using a 'trigger strategy', they show that central banks cooperate most of the time but revert to non-cooperation in periods of excessive output disturbances. Their result, however, appears inconsistent with the observation that countries do not cooperate except for special circumstances.

The rest of the paper is organized as follows. Section 2 sets up the basic model and illustrates the equilibrium construct using a simple example without the conflict between the governments and wage-setters. Section 3 introduces this conflict for symmetric countries. Section 4 allows the objectives of the domestic and foreign authorities to differ. Concluding remarks follow.

2. Costs of coordination and equilibrium regime-switching

If government officials view coordinating with other officials as costly, they will only coordinate policies during periods when the benefits exceed these costs. The private sector will then recognize this potential in forming their expectations. In addition, coordination may arise from reputation effects, particularly when the objectives of the authorities are uncertain.[2] The analysis below uses the two-country model and notation from Rogoff (1985) to demonstrate this equilibrium concept.[3] After setting up the basic framework, this section introduces the concept by imposing two further restrictions: (1) there is no conflict between the central bank and the private sector and (2) the countries are identical. These assumptions will be relaxed in the next two subsections.

[1] As in the standard Barro and Gordon (1983b) setting, this conflict arises from the authorities targeting a higher level of employment than determined in labor markets. Under time-inconsistency, Rogoff (1985) and Kehoe (1986) show that cooperation between central banks need not be optimal. Similarly, in the presence of 'political business cycles', Tabellini (1988) and Lohmann (1988) show that international cooperation can be counterproductive.

[2] Reputation models include Backus and Driffill (1985a, 1985b) and Barro and Gordon (1983a), for example. Rogoff (1987) surveys and critiques this literature.

[3] However, the construct does not depend upon a particular model and could therefore be incorporated into other similar structural models such as Canzoneri and Henderson (1987, forthcoming).

2.1. The basic model under two policy regimes

The governments at home and abroad attempt to minimize deviations of unemployment and inflation from their socially-optimal levels. Specifically,

$$\begin{aligned} \Lambda_t &= (n_t-\tilde{n})^2+\chi(\pi_t-\tilde{\pi})^2 \equiv \Lambda_{n,t}^2+\chi\Lambda_{\pi,t}^2, \\ \Lambda_t^* &= (n_t^*-\tilde{n}^*)^2+\chi(\pi_t^*-\tilde{\pi}^*)^2 \equiv \Lambda_{n,t}^{*2}+\chi\Lambda_{\pi,t}^{*2}, \end{aligned} \tag{1}$$

where Λ is the domestic government's cost function, n is employment in the home country, $\tilde{n}$ is the government's target employment level, π is the inflation rate of the home price index, and $\tilde{\pi}$ is the government's target inflation level. Here and throughout the paper, lower-case letters of variables represent logarithms unless noted otherwise and asterisks refer to the foreign counterpart. In eq. (1), the components of the government's cost function that depend upon employment and inflation are denoted $\Lambda_{n,t}$ and $\Lambda_{\pi,t}$, respectively.

The underlying structural model consists of two countries that each produce one good. Residents of each country consume both goods in equal weights of one-half of total consumption so that the consumer price indices for each country are: $\hat{p}_t \equiv p_t+0.5\ q_t$, $\hat{p}_t^* \equiv p_t^*-0.5\ q_t$, where p and p^* are the prices of the domestic and foreign good, respectively, in terms of local currency, and where q_t is the real exchange rate. Employment is determined in the labor market through a wage contracting agreement. Nominal wages are determined by a base wage, $\bar{w}$, that is set in advance, and by partial indexation to the consumer price index. Labor demand in both countries also depends upon a mutual productivity disturbance, z_t.

Given this model, the government's cost functions can be written in terms of prices, base wages, and the output disturbances:

$$\begin{aligned} \Lambda_t &= [\gamma(p_t-\bar{w})-\tau q_t+z_t-(\tilde{n}-\bar{n})]^2 \\ &\quad +\chi[p_t+(1/2)q_t-\hat{p}_{t-1}-\tilde{\pi}]^2=(\Lambda_{n,t})^2+\chi(\Lambda_{\pi,t})^2, \\ \Lambda_t^* &= [\gamma(p_t^*-\bar{w}^*)+\tau q_t+z_t-(\tilde{n}^*-\bar{n}^*)]^2 \\ &\quad +\chi[p_t^*-(1/2)q_t-\hat{p}^*_{t-1}-\tilde{\pi}^*]^2=(\Lambda_{n,t}^*)^2+\chi(\Lambda_{\pi,t}^*)^2. \end{aligned} \tag{2}$$

The employment component, $\Lambda_{n,t}$, indicates that employment depends positively upon the productivity shock, z_t, and negatively upon both the real base wage and the real exchange rate according to γ and τ, respectively.[4] The

[4]The rise in the real exchange rate reduces employment by increasing the nominal wage through indexation. The parameter α in Rogoff has been set equal to one.

term $(\tilde{n}-\bar{n})>0$ reflects the difference between the government's target employment level and the market-determined employment level in the absence of government intervention, $\bar{n}$. The private sector targets this level of employment by setting base wages equal to the expected price: $\bar{w}=E_{t-1}p_t$.

Given these cost functions, central bankers decide upon policy. Following Rogoff (1985), the analysis will investigate two particular policy regimes below. In one, called 'Nash' (N), the authorities do not coordinate policies and choose their money supplies given the other country's money supply. In the other regime, called 'coordinated' (C) below, the authorities coordinate their money supplies to keep the real exchange rate fixed so that $q_t=0$.[5] Substituting the reduced forms for p, p^*, and q into the cost functions in (2) under each regime gives Λ_t^A, the authorities costs under regime A. The first-order conditions for minimizing costs imply the following relationships:

$$\begin{aligned} \left(\frac{\partial \Lambda_t^A}{\partial m}\right)=0 \Rightarrow \left(\frac{\Lambda_{n,t}}{\Lambda_{\pi,t}}\right)=-\mu^A, \\ \left(\frac{\partial \Lambda_t^{*A}}{\partial m^*}\right)=0 \Rightarrow \left(\frac{\Lambda_{n,t}^*}{\Lambda_{\pi,t}^*}\right)=-\mu^A, \end{aligned} \tag{3}$$

where m and m^* are the domestic and foreign money supplies, respectively. μ^A is the government's optimal relative trade-off between unemployment costs and inflation costs under either regime, $A=N,C$.[6] Rogoff shows that $\mu^N>\mu^C$. Intuitively, when governments do not fix the exchange rate, adverse exchange rate movements constrain the use of monetary policy to offset unemployment disturbances. When facing this constraint, the authorities allow greater variability in unemployment relative to inflation. On the other hand, fixing the exchange rate removes this constraint so that the authorities stabilize more of the variations in $\Lambda_{n,t}$ relative to $\Lambda_{\pi,t}$. But since the private sector knows that the governments will expand money supplies more in this fixed rate system, equilibrium inflation is higher.

Ex ante, central bankers may determine whether a coordinated policy regime is preferable to Nash by taking the expected value of the cost functions across regimes and comparing them. If the variance of the output disturbance is high relative to inflation costs, they may decide to enter into a binding institutional agreement to fix the exchange rate. Therefore, to explain

[5]Of course, other cooperative regimes besides the fixed exchange rate regime are possible as will be discussed briefly in the asymmetric case in section 4.

[6]Specifically,

$$\mu^N=\frac{\chi(1+((\partial q/\partial m)/2(\partial p/\partial m))}{\gamma-\tau((\partial q/\partial m)/(\partial p/\partial m))} \quad \text{and} \quad \mu^C=(\chi/\gamma).$$

only *occasional* policy coordinations, it is assumed that the output disturbance variance is low enough that the two governments have not instituted a permanent fixed rate regime.

2.2. The costs of coordinating and the choice of regime

Even though there may be no ex ante institutional arrangements to coordinate policies, excessive output disturbances create strong incentives for the authorities to find ways to cooperate in stabilizing employment. Since the authorities know that the bad state is only temporary, the expected value of future costs under Nash is still less than under a binding fixed exchange rate regime. They could, however, benefit from a *temporary* coordination of policies for the present period only.

In an institutional environment without pre-existing mechanisms for coordinating policies, these temporary coordinations are costly, as the recent joint interest rate reductions between the United States, Japan and/or Germany suggest. Negotiating these coordinated policies requires meetings of officials from both countries. Preparations for these meetings requires compiling information on the current state of each economy. In addition, the leaders from each country must agree with each other – a position that some leaders may find politically distasteful if the popular reaction back home is to blame foreigners for the bad economic situation. Overall, the infrequency of coordination suggests that countries prefer to follow Nash most of the time and that institutional costs arise when policies are occasionally coordinated.

To illustrate this framework, suppose the following timing of events. First, the private sector sets the base wage by solving the expected price of the domestic good. Next, the output disturbance, z_t, occurs. Then, the government authorities decide whether to incur the costs to coordinate policies or to maintain Nash policies. This timing reflects the stylized fact that money markets clear quickly relative to labor markets.

Characterizing the short-term costs of coordinating requires an expression that is both tractable and relatively general. Suppose that the costs were simply constant. Then, defining the 'coordinating costs' for the domestic and foreign countries as C and C*, respectively, the social costs under coordination including this cost would be: $\Lambda_t^{C}+C$ and $\Lambda_t^{*C}+C^*$. The first-order conditions for each country following this coordinated regime would correspond exactly to those given in eqs. (3).[7] Furthermore, any form of the cost function that is independent of the current money supply would also correspond to this first-order condition. For example, the costs of coordinat-

[7]The same first-order conditions apply when costs are random, although this specification complicates the private sector's expectations problem.

ing could depend upon the difference between the inflation objectives of each country: $\tilde{\pi}-\tilde{\pi}^*$ (for example, the low inflation objectives of the Germans relative to the United States). Similarly, it could depend upon the differences in the labor market distortions, $\tilde{n}-\bar{n}$ and $\tilde{n}^*-\bar{n}^*$. Since more complicated cost functions yield the same basic results, the following analysis assumes constant costs and then describes the effects upon the equilibrium from different cost values. Perhaps surprisingly, this cost structure provides a relatively rich array of results despite its utter simplicity.

Given base wages, $\bar{w}$, the government would like to minimize costs over either regime. For notational convenience but without loss of generality, the costs of coordinating policy are assumed the same: $C=C^*$. Hence, each government's objectives at time t can be represented as follows:

$$\begin{aligned} &\min_{m=(m_{\mathrm{N}},\, m_{\mathrm{C}})} \{\Lambda^{\mathrm{N}}(\bar{w}, z_t),\ \Lambda^{\mathrm{C}}(\bar{w}, z_t)+C\},\\ &\min_{m^*=(m^*_{\mathrm{N}},\, m^*_{\mathrm{C}})} \{\Lambda^{*\mathrm{N}}(\bar{w}^*, z_t),\ \Lambda^{*\mathrm{C}}(\bar{w}^*, z_t)+C\}, \end{aligned} \tag{4}$$

where m_{A} are the money supply rules derived from either regime.

But the domestic government can only coordinate policy when the foreign government is willing. Define H as the set of values of z_t where either government is unwilling to coordinate. Then, the *feasible* policy requires jointly optimizing the objectives of both governments given this interval and base wages:

$$\begin{aligned} &\min_{m=(m_{\mathrm{N}},\, m_{\mathrm{C}})} \{\Lambda_t^{\mathrm{N}}(\bar{w}, z_t),\ \Lambda_t^{\mathrm{C}}(\bar{w}, z_t)+C \text{ s.t. } z_t \notin H\},\\ &\min_{m^*=(m^*_{\mathrm{N}},\, m^*_{\mathrm{C}})} \{\Lambda_t^{*\mathrm{N}}(\bar{w}^*, z_t),\ \Lambda_t^{*\mathrm{C}}(\bar{w}^*, z_t)+C \text{ s.t. } z_t \notin H\}, \end{aligned} \tag{5}$$

where $H=\bar{H}\cup\bar{H}^*$ for $\bar{H}$ $(\bar{H}^*)$, the set of disturbances where the home (foreign) government is unwilling to temporarily coordinate monetary policies. H is the union of these two intervals because for any $z\notin\bar{H}$ but $z\in\bar{H}^*$, only the home country but not the foreign country wants coordination.

2.3. Equilibrium for symmetric countries without time-inconsistency

To illustrate the equilibrium range of H, consider first a more restrictive form of the model. The countries have identical inflation and employment targets, $\tilde{\pi}=\tilde{\pi}^*$, and there is no conflict between the authorities and the labor market's target employment rates, i.e. $\tilde{n}=\bar{n}$ and $\tilde{n}^*=\bar{n}^*$. Since in this case the

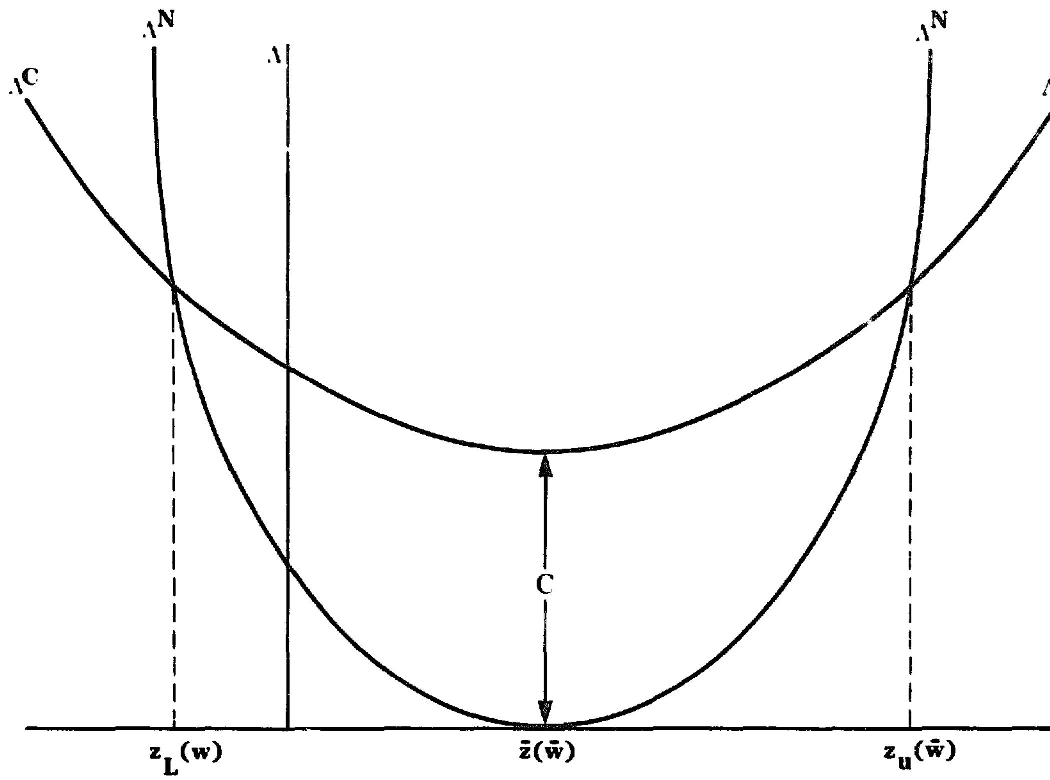

Fig. 1. Social cost functions for each regime given arbitrary mutual base wages.

domestic and foreign output prices are equal in equilibrium, only the domestic price will be discussed.

The governments take the private sector's base wages, $\bar{w}$, as given when they decide upon policy. Fig. 1 illustrates the cost functions under either regime over the range of z_t for a given base wage. Substituting the optimal policy rules in each regime into the cost functions in eq. (2), differentiating with respect to z_t and setting them equal to zero, verifies that the cost functions are minimized at the same level, $\bar{z}$, for both regimes:

$$\bar{z}=\gamma(\bar{w}-\hat{p}_{t-1}-\bar{\pi}). \tag{6}$$

From (6) it is clear that this minimum point occurs at $\bar{z}=0$ since the private sector sets $\bar{w}=\mathrm{E}_{t-1}p_t=\hat{p}_{t-1}+\bar{\pi}$.

Although both regimes share the same $\bar{z}$, the minimum cost is higher for coordination due to the cost of coordination, C. In addition, since disturbances are stabilized less under Nash than under cooperation, the cost function rises more quickly for Λ^N than Λ^C (easily verified by differentiating the cost functions with respect to z). Hence, Λ^N intersects Λ^C at z_L and z_U. Above z_U and below z_L, the governments minimize costs by fixing the exchange rate. So the sets of z where each country does not want to coordinate policy are the same, i.e. $\bar{H}=\bar{H}^*=H=(z_L,z_U)$.

Since the private sector's objectives are to set base wages equal to the expected price, they first solve for the price level under either monetary regime, and then take expectations of the outcome. Therefore, integrating over the different intervals of z, the expected price can be written:

$$E_{t-1}p_t=\int_{z_L}^{z_U} p_t^N f(z)\,dz+\left[\int_{-\infty}^{z_L} p_t^C f(z)\,dz+\int_{z_U}^{\infty} p_t^C f(z)\,dz\right]. \tag{7}$$

Under rational expectations, the boundaries of the interval of z where the authorities actually move to coordinate policies is equal to the boundaries the private sector uses in calculating the probabilities in eq. (7). As fig. 1 illustrates, finding these boundary points simply requires setting $\Lambda_t^N=\Lambda_t^C$ and solving for z_L and z_U. Since the cost functions are parabolas, the bounds of the non-cooperative range are completely determined by the costs and the parameters of the model so that: $z_L=\bar{z}-J$ and $z_U=\bar{z}+J$, where J is a constant.[8] Furthermore, since in equilibrium the minimum point equals zero, $z_L=-J$ and $z_U=J$.

To solve for the reduced-form prices under either the Nash regime of the coordinated regime requires several steps.[9] Then substituting into this reduced form the simplifying assumptions from this section – $\tilde{\pi}=\tilde{\pi}^*$, and $\tilde{n}-\bar{n}=\tilde{n}^*-\bar{n}^*=0$ – implies the following form of prices under either regime:

$$p_t^A=\lambda^A[\gamma\bar{w}+\mu^A(\hat{p}_{t-1}+\tilde{\pi})]-\lambda^A z_t\equiv\bar{p}_t^A-\lambda^A z_t, \tag{8}$$

where $\lambda^A\equiv 1/(\mu^A+\gamma)$ and $\bar{p}_t^A$ is the predetermined component of p_t^A. Thus, the price in each regime depends upon the predetermined variables $\bar{w}$, $\tilde{\pi}$, and $\hat{p}_{t-1}$, and upon the residual effect that the disturbance exerts upon the price level after monetary intervention, $\lambda^A z_t$. Substituting the price equations in (8) into eq. (7) yields the expected output price under regime-switching. This expected price depends upon a probability-weighted average of the prices that would emerge from each regime. Defining the probability that the authorities will follow regime A as S^A: $S^N\equiv\text{Prob}(z\in H)$, $S^C\equiv\text{Prob}(z\notin H)$. Then the expected output price becomes:

[8]In particular, $J\equiv\sqrt{C/[(\lambda^C)^2(\chi+(\mu^C)^2)-(\lambda^N)^2(\chi+(\mu^N)^2}$.

[9](1) Solve the endogenous variables in terms of the exogenous variables and substitute the results into the authorities' first-order conditions. (2) Solve these first-order conditions in terms of m and m^* to get the reaction functions. (3) For Nash, solve the two reaction functions in terms of the base wages and the disturbance. Under the coordinated regime, use the relative money supply relationship implied by $q=0$. (4) Substitute these relationships from each regime into the price equations to get reduced-forms.

$$E_{t-1}p_t = \sum_{A=N,C} S^A \bar{p}_t^A - (\lambda^C - \lambda^N) \int_{z \in H} z f(z)\, dz$$

$$= \sum_{A=N,C} S^A \bar{p}_t^A = \int_{z_L}^{z_U} f(z)\, dz\, \bar{p}_t^N + \left(1 - \int_{z_L}^{z_U} f(z)\, dz\right) \bar{p}_t^C. \qquad (9)$$

The second line follows because z has mean zero and the range of $z \in H$ is symmetric around zero (i.e. $\bar{z}=0$). Thus, the expected price is simply a probability-weighted average of the predicted components of the price under each regime.

2.4. Discussion of the cost technology in the equilibrium construct

The equilibrium construct developed above uses a simple contracting technology through which governments can coordinate policies. Through this technology, the authorities can occasionally coordinate policies even though they do not have a standing institutional agreement in force every period.[10] Since the authorities must initiate policy coordination agreements anew when shocks are occasionally excessive, it is natural to include the contracting cost technology explicitly into the determination of inflation and employment. Use of this contracting technology is similar to the costs of transacting employed in other issues in economics.[11]

3. Symmetric countries under time-inconsistency

The section investigates the equilibrium when the authorities target a higher level of employment than the labor market. Using the equilibrium concept developed above, the model implies an endogenous range of the disturbance where Nash occurs. This case is more relevant for studying the regime of policy-switching since under a permanent fixed exchange rate regime the presence of time-inconsistency creates an inflation bias. Without this bias, a fixed exchange rate regime is always ex ante preferable to Nash so that the authorities are likely to already follow permanent fixed rate agreements. Until the next section, the countries are assumed to have symmetric inflation targets and labor market distortions: $\tilde{n}-\bar{n}=\tilde{n}^*-\bar{n}^*$, $\tilde{\pi}=\tilde{\pi}^*$.

[10] These standing institutional agreements are usually assumed to come from outside of the model. See, for example, Friedman (1986, ch. 1).

[11] For example, Backus and Driffill (1985b) assume that the private sector faces fixed transactions cost of 'believing' the central bankers. On generally incorporating the contracting technology into the equilibrium, see Shubik (1980). Examples of issues in economics that have incorporated costs of transacting are labor market organization, vertical integration, family organization, and industry regulation/deregulation. See Williamson (1986) and the references therein.

3.1. Derivation of the equilibrium given the policy-switch points

As before, the authorities take base wages as given and decide upon policy based upon observing that period's output disturbance level. But now the authorities would like to systematically expand the money supply to push down the real wage. Private agents, realizing this incentive, raise inflationary expectations and, hence, equilibrium inflation. Substituting the optimal policy rules, m^{N} and m^{C}, into the cost functions and differentiating as before reveals the minimum point of the cost functions given base wages as

$$\bar{z} = \gamma(\bar{w} - \hat{p}_{t-1} - \bar{\pi}) + (\tilde{n} - \bar{n}). \tag{10}$$

Comparing eq. (10) to eq. (6) indicates that the minimum point now depends upon the labor market distortion. Fig. 1 illustrates the positions of the cost functions in equilibrium. Due to the time-inconsistency of the authorities' objectives, the minimum point of the governments' costs occur at a positive value of z, as will be demonstrated below. Since the authorities prefer a higher employment level than occurs at the market-determined level of $\bar{n}$, their costs are minimized only when the productivity shock is positive by a large enough value to offset the labor market distortion. This minimum point, $\bar{z}$, is endogenously determined by the interaction of the private sectors expectations and the authorities' objectives.

The private sector realizes that setting base wages determines the position of the governments' cost functions in fig. 1. To set base wages, the private sector forms expectations based upon the policy-switch points, z_{L} and z_{U}, as in eq. (7). While these points will shortly be derived endogenously, assume for now a given range of H.

As before, the solution of the price under either arbitrary regime implies that: $p_t^{\mathrm{A}} = \bar{p}_t^{\mathrm{A}} - \lambda^{\mathrm{A}} z_t$, as in eq. (8), but now, since the government target employment levels differ from the market-determined levels,

$$\bar{p}_t^{\mathrm{A}} \equiv \lambda^{\mathrm{A}}[\gamma\bar{w} + \mu^{\mathrm{A}}(\hat{p}_{t-1} + \bar{\pi})] + \lambda^{\mathrm{A}}(\tilde{n} - \bar{n}). \tag{11}$$

Comparing the predetermined components of prices in (11) and (8) reveals that they differ according to the inflationary tendency of the central banks, $\lambda^{\mathrm{A}}(\tilde{n} - \bar{n})$. Clearly, the effect of this inflationary bias is greater under coordination than Nash since $\lambda^{\mathrm{C}} > \lambda^{\mathrm{N}}$.

Also as before, taking expectations of prices across both regimes gives the expected output prices. For notational convenience, eq. (9) is rewritten in the following form:

$$\mathrm{E}_{t-1} p_t = \sum_{\mathrm{A}=\mathrm{N},\mathrm{C}} S^{\mathrm{A}} \bar{p}_t^{\mathrm{A}} - z^{H}, \tag{9'}$$

where $z^H \equiv (\lambda^C - \lambda^N) \int_{z \in H} z f(z)\,dz$. Imposing the further condition that wage setters set $\bar{w} = E_{t-1}p_t$ upon eq. (9′) and solving for $\bar{w}$ yields:

$$\bar{w} = E_{t-1}p_t = (p_{t-1} + \tilde{\pi}) + [G/(1-\gamma G)](\tilde{n} - \bar{n}) + z^H/(1-\gamma G), \tag{12}$$

where $G \equiv \lambda^N S^N + \lambda^C S^C$, the expected response of monetary policy to the disturbance.

Unlike the case in section 2, the interval of Nash is not symmetric around zero so that the term z^H does not integrate to zero. Instead, z^H reflects the expected monetary policy responses over all possible realizations of the disturbance. When following the coordinated regime, the authorities offset disturbances more than under the Nash regime. Therefore, in response to negative realizations of z_t, the authorities inflate more in the fixed exchange rate range than in the Nash range. Since coordination occurs more often than Nash at negative output disturbances, the expected value of z in the interval H must be positive, implying $z^H > 0$.

3.2. *The equilibrium policy-switch points*

So far, this analysis has taken as given the boundary points, z_L and z_H, where the authorities switch from a Nash regime to a coordinated fixed exchange rate regime. Determining the dynamically consistent probabilities, S^A, and hence, the dynamically consistent expected inflation rates in (12), requires solving for these boundary points. Since the true probabilities of the central bankers following a Nash policy are $S^N = \int_{z \in H} f(z)\,dz$, the expected probabilities set by the private sector are rational if the bounds of H they use to calculate their expectations are indeed the actual bounds.

To find the bounds given $\bar{w}$, set $\Lambda_t^N = \Lambda_t^C$ and solve for z_L and z_U, as before, giving: $z_L = \bar{z} - J$, $z_U = \bar{z} + J$. Since the bounds of H are uniquely determined by $\bar{z}$, solving the equilibrium requires finding the expected prices, $E_{t-1}p_t$, that yield $\bar{z}$ consistent with the initial expectations.

To find this equilibrium $\bar{z}$, first look at the minimum cost disturbance that is implied by setting different base wages in eq. (10). This relationship describing the governments' reactions to different base wages is positive and linear. Fig. 2 shows this mapping from $\bar{w}$ to $\bar{z}$ as $\bar{z} = g(\bar{w})$. Next, from eq. (12) the private sector uses different expected levels of $\bar{z}$ to form forecasts of the price level. Differentiating this wage equation with respect to $\bar{z}$ implies the relationship between $\bar{z}$ and $\bar{w}$ depicted in the figure as $\bar{w} = r(\bar{z})$ when z has a normal distribution. In this case, $r'(\cdot)$ is strictly positive and $r''(\cdot)$ is strictly negative for $\bar{z} > 0$. The fixed point where $g(\cdot)$ and $n(\cdot)$ intersect determines the equilibrium base wages and the minimum social cost disturbance level, $\bar{z}_0$.

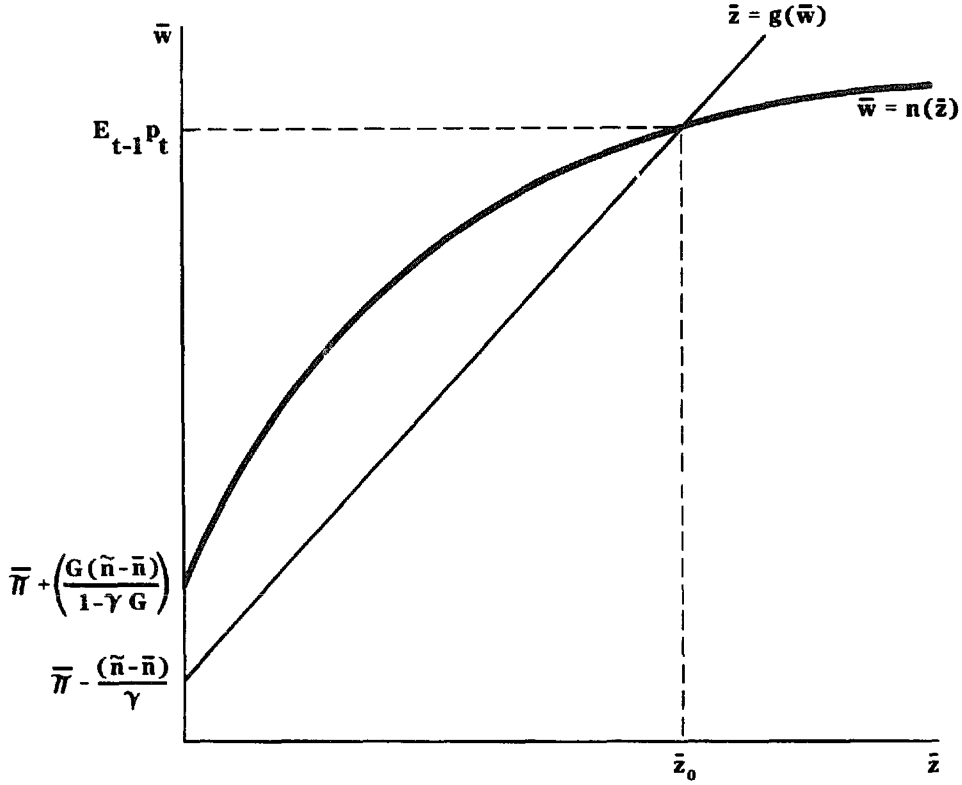

Fig. 2. Equilibrium regime-switching bounds and expectations for the symmetric case. Note: $\bar{\pi} = \hat{p}_{t-1} + \bar{\pi}$.

Since $r(0) > g^{-1}(0)$, the positive equilibrium value of $\bar{z}_0$ exists and is unique.[12]

3.3. Description of the equilibrium

The asymmetric response of policy regimes to realizations of the output disturbances, illustrated in fig. 1, is an interesting feature of endogenous policy-switching. Due to the presence of the distortions in the economies and costs of coordination, the governments will, on average, prefer not to coordinate when disturbances are positive since these disturbances raise employment above the levels determined ex ante in the labor market. When disturbances are negative, however, both countries are more likely to want to coordinate policies.

The effects of different levels of the costs, C, are also interesting. Large costs imply a relatively wide range of disturbances where Nash policies are followed. When these costs are infinite, they correspond to the case when ex post regime-switching is impossible, as in Rogoff (1985). It might therefore be

[12]Assuming further that $\bar{y} > \gamma(\hat{p}_{t-1} + \bar{\pi})$ insures that a second 'perverse' equilibrium does not occur in the range of z from $r^{-1}(0)$ to 0.

tempting to conclude that if costs were small, coordination would occur most of the time. But such an argument would be too simplistic. Since the variance of the disturbance is relatively small by assumption (the reason why the authorities have not entered into an institutional agreement to fix the exchange rate every period), most of the probability mass of the distribution is concentrated near zero. If this variance is small enough and if the equilibrium minimum cost point. $\bar{z}$, is sufficiently close to zero, non-cooperative policies my occur most of the time even with very small values of C. Generally speaking, how frequently Nash or 'fixed exchange rate' policies occur depends upon, not only the costs, but the probability distribution of the output disturbances.

4. Policy-switching for asymmetric countries

When the objectives of domestic and foreign authorities differ, the foreign government objectives affect domestic output prices through the private sector's expectations incorporating potential coordinations of policy. This section investigates the case when $\tilde{n}-\bar{n}\neq\tilde{n}^*-\bar{n}^*$ and $\tilde{\pi}\neq\tilde{\pi}^*$. Allowing the objectives to differ and re-solving the prices in either regime implies the following reduced forms:

$$\begin{aligned} p_t^{\mathrm{A}} &= \bar{p}_t^{\mathrm{A}} - \lambda^{\mathrm{A}} z_t - k^{\mathrm{A}}\lambda^{\mathrm{A}}(W^{\mathrm{A}} - W^{\mathrm{A}*}), \\ p_t^{*\mathrm{A}} &= \bar{p}_t^{\mathrm{A}*} - \lambda^{\mathrm{A}} z_t - k^{\mathrm{A}}\lambda^{\mathrm{A}}(W^{\mathrm{A}} - W^{\mathrm{A}*}), \end{aligned} \tag{13}$$

where

$$W^{\mathrm{A}} \equiv \mu^{\mathrm{A}}(\bar{w} - \hat{p}_{t-1} - \tilde{\pi} - [(\tilde{n}-\bar{n})/\mu^{\mathrm{A}}]),$$

$$W^{\mathrm{A}*} \equiv \mu^{\mathrm{A}}(\bar{w}^* - \hat{p}_{t-1}^* - \tilde{\pi}^* - [(\tilde{n}^*-\bar{n}^*)/\mu^{\mathrm{A}}]),$$

and k^{A} is a constant positive coefficient from the underlying structural model. As before, the prices depend upon the predetermined variables and the effect from the disturbance under either regime, $\lambda^{\mathrm{A}} z_t$. In the present case, however, prices also depend upon the terms, W and W^*, that represent the effects from both the domestic and the foreign price of setting base wages at levels other than the expected price conditional on regime A exclusively.

Taking expectations of (13) across regimes and then imposing the condition that $\bar{w}=\mathrm{E}_{t-1}p_t$ and $\bar{w}^*=\mathrm{E}_{t-1}p_t^*$ gives the equilibrium expected prices solely in terms of conditional probabilities (S^{A}), the labor market distortions ($\tilde{n}-\bar{n}$, $\tilde{n}^*-\bar{n}^*$), and the expected value of the disturbances effect upon the price (z^H).

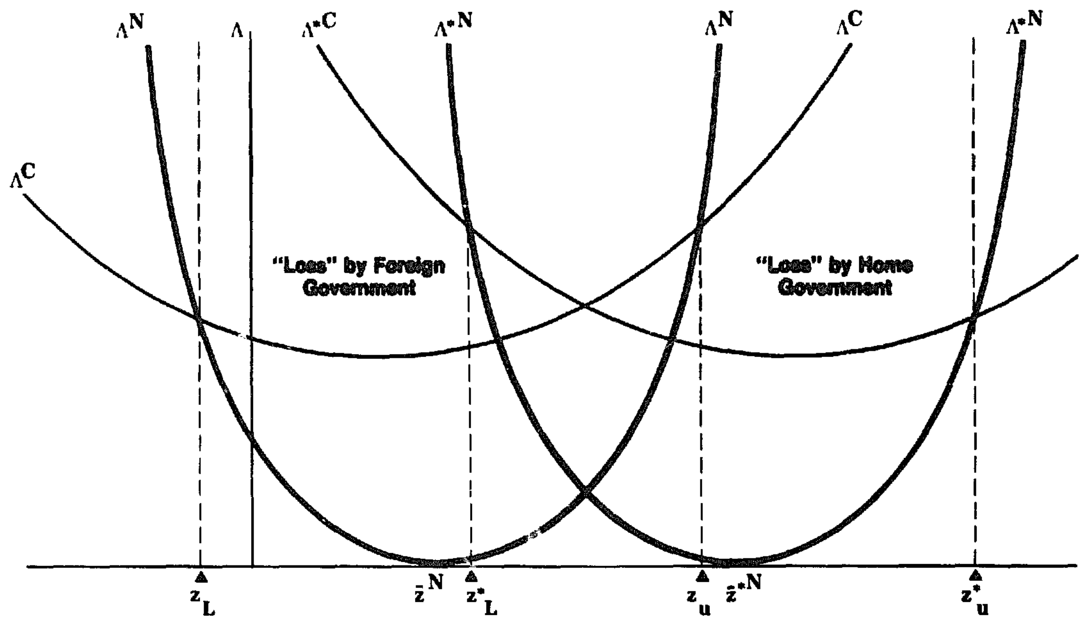

Fig. 3. The switching equilibrium.

To illustrate the endogenous switch points in this case, assume that the foreigners have a larger labor market distortion than the home country so that $\tilde{n}^* - \bar{n}^* > \tilde{n} - \bar{n}$. Fig. 3 depicts the cost functions for each country under the temporary fixed rate regime as Λ^{C} and Λ^{*C}. Since the foreign distortion is greater than the domestic distortion, foreigners require a larger disturbance to offset the costs of their distortion. Therefore, Λ^{*C} and Λ^{*N} lie to the right of Λ^{C} and Λ^{N} along the z-axis.[13]

As is clear from fig. 3, the difference between the two countries' labor market distortions and objectives creates a conflict between domestic and foreign monetary authorities. For disturbances in the interval between z_L and z_U^*, each country follows their own Nash policies. Within this range, domestic authorities would like to fix the exchange rate for disturbances exceeding z_U but the foreign government is unwilling. On the other hand, for values of the disturbances less than z_L^* but greater than z_L, foreign authorities complain about the unwillingness of domestic authorities to coordinate policies. The more the labor market distortions differ, the wider is the range of disturbances where either country complains.[14] For some levels of z that are close to the boundary points, z_L and z_U^*, the diagram suggests that, if costs could be transferred, one government may be willing to make 'side payments' to the other government to induce coordination. This indicates that, for some realizations of the disturbance, an asymmetric policy regime response may be superior to the symmetric fixed exchange rate regime

[13]The asymmetry in policy objectives by the two governments also implies that the Nash and coordinated regime cost functions no longer share the same minimum cost disturbance.

[14]If $z_U < z_L^*$, as would occur if the foreign labor market distortion were very large relative to that of the home country, an intermediate range of coordination on (z_U, z_L^*) would emerge.

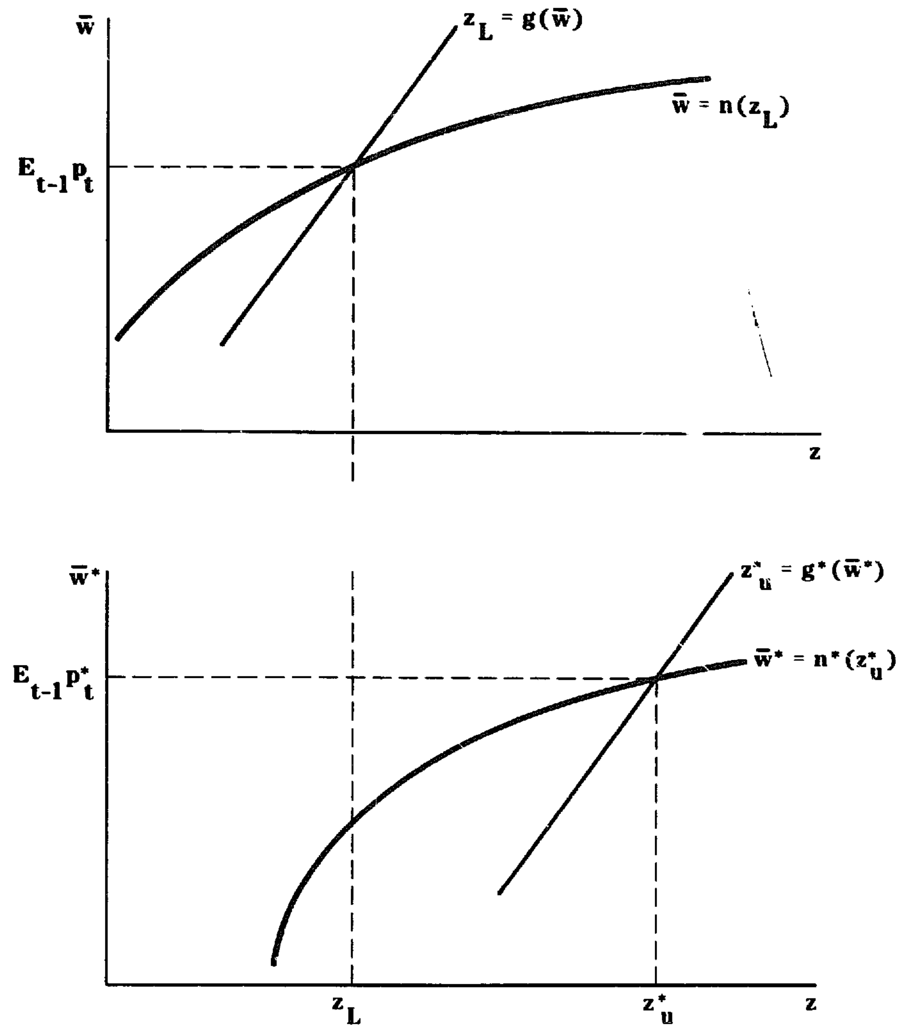

Fig. 4. Equilibrium regime-switching bounds and expectations.

analyzed here. If asymmetric policy coordinations were possible, the private sector would also recognize these potential regime responses in their expectations in addition to the simple two-regime case.

As in the symmetric case, when disturbances are negative both authorities agree to coordinate fixed rate policies more often than when shocks are positive. For positive disturbances, non-cooperative policies are usually preferred since these disturbances raise output closer to the socially optimal level. But for negative disturbances, the authorities are more likely to find the benefits to coordination worth the costs.

The bounds where cooperation occurs depend upon market-set base wages. In turn, market-set base wages depend upon expectations concerning these bounds, z_L and z^*_U. As before, the bounds used in expectations must in equilibrium equal the actual bounds where the authorities cooperate. Fig. 4 describes these relationships. First, given base wages, the authorities will coordinate monetary policies outside of bounds determined by the value of z, where $\Lambda_t^{\mathrm{N}} = \Lambda_t^{\mathrm{C}} + C$. The values of z_{L} given $\bar{w}$ implies the relationship $g(\bar{w})$ in fig. 4. Following the same process for the foreign country, the effect of $\bar{w}^*$ on z_{U}^* is given by $g^*(\bar{w}^*)$. Second, wage-setters set expectations according to different anticipated bounds, z_{L} and z_{U}^*. This response, given by $r(\cdot)$ and $r^*(\cdot)$, is also positive. The points where the actual cooperative bounds are equal to expectations give equilibrium bounds and base wages.[15]

5. Concluding remarks and further extensions

This paper has demonstrated a motivation for why monetary authorities may occasionally coordinate policies, even though most of the time they do not. Although ex ante the domestic authority prefers not to bind into a fixed exchange rate agreement with the other monetary authority, sufficiently large output disturbances make the costs of instituting a temporary policy coordination worthwhile. Therefore, policy coordinations occur occasionally when the gains to coordination are large enough. In addition, the analysis demonstrates that coordination is more likely from negative output disturbances, implying lower employment, than from positive output disturbances.

Specifying a technology through which the authorities could occasionally coordinate policies was an important ingredient in the analysis. For simplicity, it was assumed that this technology could be implemented through a constant cost. Presumably, this cost may itself be determined endogenously through the interactions of the central banks. Investigating sources of the coordinating costs and their interactions with the equilibrium may provide further motivation for observed central bank behavior.

[15] In this case, multiple equilibria cannot be ruled out. Experimentation with different distributions of z suggests that the greater the kurtosis and the more distinct the two regimes, the more likely a unique equilibrium.

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