Monetary policy in open economies

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Abstract

The recent literature on monetary policy in open economies has produced a strong presumption in favor of activistic policy and flexible exchange rates. We argue that this result may owe much to the combination of two commonly made assumptions: That nominal goods prices are rigid. And that the monetary authorities have a lot of information about the economy. When the source of nominal rigidity is found in wages and monetary policy is conducted under conditions of imperfect information about the shocks and the structure of the economy, policies that stabilize the money supply or the nominal exchange rate may perform better.

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Introduction

The properties of alternative international monetary arrangements have been studied extensively in the literature, first within the Mundell-Fleming and lately within the New Keynesian (NK) model. The former model has identified two key factors that make the fixing of the exchange rate costly: a) Dissimilarities in economic structure, and in particular, in the degree of asymmetry in the shocks. And, b) high degree of nominal rigidities. Asymmetric shocks generate a need for terms of trade adjustment. If the necessary adjustment cannot occur directly through wage and price changes, it may be accomplished indirectly via exchange rate changes (see Friedman's, 1953, case for flexible exchange rates).

The NK model uses diverse "formats" and has produced rather diverse findings. Nevertheless, its main conclusion echoes that of the traditional Mundell-Fleming model (at least under producer currency pricing) and for the same reasons. Namely, abstracting from non-fundamental fluctuations and speculative attacks, flexible exchange rate systems tend to fare better than regimes that severely restrict exchange rate fluctuations (Begigno and Begigno, 2003, Kollmann, 2001, Obstfeld and Rogoff, 2001, Pappa, 2004, Stockman and Ohanian, 1993). Moreover, independent national monetary policy performs quite well, that is, there exist small gains from international policy coordination. While objections to the general validity of these results have been raised[1] they have not undermined their wide acceptance.

There are good reasons to believe that the alleged superiority of monetary policies that feature activism, absence of international coordination and a flexible exchange rate may not be as general as it appears. First, it is typically assumed that the monetary authorities have *complete information* about the structure of the economy and the shocks. Combining this with the assumption that monetary policy is conducted optimally, that is, that it aims at maximizing the utility of the representative agent, allows these models to often generate activistic policy equilibria that replicate the efficient, flexible price (or wage) equilibrium. Consequently, when monetary policy is omniscient and omnipotent, it is not sensible to constrain it by making it target the exchange rate. This is specially

[1]Two main exceptions have been identified. The use of LCP with buyer's currency improves the relative performance of fixed regimes (Devereux and Engel, 2003, Duarte, 2003). And the presence of an incentive to exploit the country's market power strengthens the case for international policy coordination (even in the form of a fixed regime); Canzoneri, Cumby and Diba, 2005, Pappa, 2004).

true when beggar-thy-neighbor effects associated with independent policies are not strong (for instance, when domestic and foreign goods are poor substitutes, see Pappa, 2004).

Second, the ability to manipulate the nominal exchange rate is more useful when there is no production interdependence across countries. If there is also trade in intermediate (capital) goods then an exchange rate depreciation may have adverse, direct effects on the cost of domestic production which go against those on relative demands and which make the exchange rate instrument less useful[2]. Again it is typical in this literature to assume that trade involves only consumption goods[3].

And third, most of the existing literature assumes nominal price rigidities. When prices are rigid, fixing the exchange rate incapacitates a mechanism that could bring about desired relative price changes (see Friedman's, 1953, case for flexible rates). While this adjustment mechanism could remain in place even under nominal wage rigidities, its role in existing models with nominal wage rigidity tends to be limited due to the combination of the assumptions of imperfect competition and a single input (labor) which transfers nominal wage to nominal price rigidity (Obstfeld and Rogoff, 2000).

The objective of this paper is to examine the role played by these factors for the properties of alternative exchange rate systems as well as the desirability of standard interest rate policies (such as the Hendersonn, McKibbin, Taylor, HMT, rule). This is important for a number of reasons. First, the assumption of perfect information may be a useful benchmark but is clearly unrealistic. Hence a policy recommendation that required that monetary authorities possessed an extraordinary amount of information might be of limited value. Second, there exists considerable uncertainty regarding the relative strength of alternative sources of nominal frictions (price vs wage) in the real world (see Christiano, Eichenbaum and Evans, 2001, Smets and Wouters, 2003). A policy prescription that would be valid under only one type of rigidity but not under another might be too risky to adopt. And third, international trade involves both consumption and intermediate goods.

The model employed is highly stylized but contains all the points of contention raised

[2]In graphical terms, a depreciation shifts both the demand and the supply curve for domestic goods upward. See De Grauwe, 2000.

[3]There are several works that use traded intermediate goods (for instance, Collard and Dellas, 2002, Chari, Kehoe and McGrattan, 2000, Kollmann, 2001) but do not deal explicitly with the issues discussed here. Kollmann is an exception but his evaluation of alternative regimes omits transitional effects, so his welfare comparisons are not complete.

above: nominal wage vs price rigidities, international production and consumption interdependence and a variety of *unobservable* shocks. Issues of strategic interaction between the policymakers in the two countries are left out as this is a distinct issue with no direct relationship to the informational issues investigated here. The main results are the following:

First, standard interest rate policy rules and a flexible exchange rate regime fare well under nominal price rigidity as long as the degree of imperfect information is not too high. Second, production interdependence does not undermine the case for a flexible exchange rate regime. And third, nominal wage rigidity and imperfect information favor policies that target the money supply and/or the nominal exchange rate.

These findings also have implications for international policy coordination. Obstfeld and Rogoff, 2001 argue[4] that in situations where global monetary policy can replicate the flexible wage equilibrium, "...lack of coordination in rule setting is a second-order problem compared to the gains from macroeconomic stabilization.." We find that under price rigidity *independent* national, uncoordinated, monetary policies can deliver superior results even when monetary policy does not have the ability to replicate the flexible price equilibrium, as long as information is not too imperfect.

The rest of the paper is organized as follows: Section 1 presents the model. Section 2 reports the main findings.

1 The model

The model employed is a standard two country model. The main differences from the those typically used in the literature are the following: First, the shocks are assumed to be unobservable[5]. Second, both production and consumption trade interdependence are allowed by introducing intermediate goods. And third, it is assumed that there exists perfect rather than imperfect competition in goods markets so that market structure does not vary with the type of nominal rigidities.

[4]See, however, Canzoneri, Cumby and Diba, 2005, and Pappa, 2004, for cases in which international policy coordination matters.

[5]Benigno and Benigno, 2000 evaluate the performance of alternative *interest rate* rules as well as of exchange rate systems in a two country model without requiring knowledge of the shocks. But they only examine the case of price rigidity, do not include direct production interdependence and do not have a full menu of shocks.

1.1 The firms

There are two types of firms: Those that produce intermediate goods and those that produce consumption goods.

The domestic intermediate goods firms produce a single, homogeneous good. In each period they lease labor, h_t and purchase an intermediate good X_t in order produce. They maximize current profits

$$\pi_t = P_{Ht}X_t - W_t h_t - Z_t K_t \tag{1}$$

where X_t is the total output of the domestic intermediate good and P_{Ht} its domestic currency price. W_t and Z_t are the nominal wage and price of intermediate good respectively.

X_t is produced according to the production function

$$X_t = A_t(K_t)^{\alpha}(h_t)^{1-\alpha} \tag{2}$$

where A_t is a stationary, exogenous, stochastic technology shock. K_t is a composite good. In particular,

$$K = \left(s^{1-\rho}X_H^{\rho} + (1-s)^{1-\rho}X_F^{\rho}\right)^{1/\rho} \tag{3}$$

where X_H and X_F are the quantities of the domestic and foreign intermediate goods used in the production of the domestic intermediate good. The corresponding price index of K is

$$P_k = \left(sP_H^{\frac{\rho}{1-\rho}} + (1-s)(s_t P_F)^{\frac{\rho}{1-\rho}}\right)^{\frac{1-\rho}{\rho}} \tag{4}$$

where P_H and P_F are the prices of the domestic and foreign intermediate goods (in the respective currency) and s_t is the nominal exchange rate (units of domestic per unit of foreign currency).

The firms in the consumption goods sector combine intermediate goods from both countries to produce a single, homogeneous consumption good, C. In particular,

$$C = \left(\omega^{1-\phi}C_H^{\phi} + (1-\omega)^{1-\phi}C_F^{\phi}\right)^{1/\phi} \tag{5}$$

where C_H and C_F denote the quantities of the domestic and foreign intermediate goods that are used in the production of the domestic consumption good. The corresponding price index is

$$P_c = \left(\omega P_H^{\frac{\phi}{1-\phi}} + (1-\omega)(s_t P_F)^{\frac{\phi}{1-\phi}}\right)^{\frac{1-\phi}{\phi}} \tag{6}$$

The domestic resource constraint is then

$$X_t = C_{Ht} + C^*_{Ht} + X_{Ht+1} + X^*_{Ht+1} + G_t \tag{7}$$

where C^*_{Ht} and X^*_{Ht+1} denote the amounts of the domestic intermediate good that are used for consumption and production purpose respectively. G_t is domestic public spending.

The problem of the foreign firms is completely analogous. The foreign resource constraint is

$$X^*_t = C_{Ft} + C^*_{Ft} + X_{Ft+1} + X^*_{Ft+1} + G^*_t \tag{8}$$

where G^* is foreign government expenditure.

1.2 The household

Let us now turn to the description of the behavior of the domestic agents. The domestic household's optimization problem is given by:

$$E_0 \max \sum_{t=0}^{\infty} \beta^t \frac{1}{1-\sigma}\left[\left(\left(C_t^{\eta} + \zeta_t\left(\frac{M_t}{P_t}\right)^{\eta}\right)^{\frac{\nu}{\eta}} \ell_t^{1-\nu}\right)^{1-\sigma} - 1\right]$$

subject to

$$\ell_t + h_t = 1$$

and

$$B_{t+1} + s_t B^*_{t+1} + M_t + P_{ct}C_t + P_{xt}X_{t+1} + T_t \quad \leq \tag{9}$$

$$R_{t-1}B_t + s_t R^*_{t-1}B_t + M_{t-1} + N_t + \Pi_t + W_t h_t + Z_t K_t \tag{10}$$

where B_t is domestic holdings of one period domestic currency bonds acquired in period $t-1$, B^*_t is domestic holdings of foreign currency bonds, R_t and R^*_t are the corresponding gross, nominal one period interest rates, s_t is the nominal exchange rate, M_t is domestic

currency held at the end of period t, C_t and X_t are the domestic consumption and investment composites (comprising of domestic and foreign goods); P_{ct} and P_{xt} are the corresponding price indexes; W_t is the nominal wage and Z_t the rental rate on capital; ℓ_t is leisure and h_t is work; T_t is *lump-sum taxes*, $\Pi(s^t)$ are the profits of the firms and N_t is the per-capita amount of domestic money received by the domestic agent. Recall that it is assumed that the depreciation rate is equal to unity.

With this specification one can introduce "money -demand- shocks" by allowing the weigh of the real balance term in the utility function, ζ_t, to vary stochastically.

The problem of the foreign household is completely analogous.

1.3 Nominal rigidities

The model is solved under either fixed prices or fixed nominal wages. In particular, it is assumed that prices (wages) are fixed one period in advance at the level P_i (W_i), $i = H, F$ that corresponds to the expected market clearing price (wage). That is, prices (wages) are set using contracts of the form $J_{it} = E_{t-1}\widetilde{J}_{it}$, $J = P, W$ where $\widetilde{J}_{it}$ is the price (wage) that would clear the goods (labor) market under flexible prices (wages). The fixed price (wage) then replaces the output (labor) supply equation as the firms (workers) must supply the quantity demanded at this price (wage).

1.4 The government

In each and every period, the home government acquires an amount G_t of the domestic intermediate good and converts into consumption on a one to one basis. Expenditures are financed by means of lump–sum taxation:

$$P_{Ht}G_t = T_t \tag{11}$$

Similar equations characterize the behavior of the foreign government.

1.5 Monetary policy

A commonly made assumption in the literature is that the monetary authorities can observe and react to the economic disturbance contemporaneously. As is well known in this case, it is often possible to undo the effect of nominal rigidities and thus replicate the flexible price (wage) equilibrium. This requires a flexible exchange rate regime.

In this paper such information is ruled out. The policy rules considered here[6] under a flexible exchange rate system involve either the targeting of the money supply (a rigid rule) or a reaction to price and output deviations from target (a flexible rule). The latter rule takes the form of a variation of the popular HMT rule. In particular,

$$M_t = 0 constant$$

and

$$R_t = k_p P_{c,t} + k_y Y_t + k_{p1} P_{c,t-1} + k_{y1} Y_{t-1}$$

where M_t is the money supply and P_t and Y_t represent deviations from the price and output targets respectively in period t. The targets are set equal to the corresponding steady state values. Note that neither of these rules requires shock observability.

The simplest way to capture differences in the degree of information to the monetary authorities is by varying the time index of the macroeconomic variables (prices and output) to which monetary policy reacts to. Two cases are considered: A reaction to contemporaneous values. And a reaction to lagged values. The latter case is assumed to correspond to a less well informed monetary authority than the former.

The two international arrangements considered are a flexible system and a bilateral peg. In the latter case, the monetary authorities either jointly target the "world" money supply subject to the constraint that the exchange rate must remain fixed (a rigid rule). Or, they operate an HMT rule but under the additional constraint that the exchange rate must remain fixed. Such a rule requires that the policymakers in both countries adjust nominal interest rates by the same amount (so that the exchange rate does not change) in response to output and price developments in *either* country. It should be noted that such a hard peg is virtually indistinguishable from a monetary union as its operation involves using the –common– interest rate to respond to deviations of world output and inflation from their –common– target levels[7].

[6]It should be emphasized that no analysis of optimal monetary policy is attempted in this paper. This is not because this task poses any serious computational difficulties or is uninteresting but rather because the derivation of the optimal policy is not necessary for the evaluation of alternative, actual, monetary practices. There already exists a huge literature that deals with the former but a much smaller one dealing with the –practically more important– latter.

[7]This equivalence owes to the assumption that the two countries are of the same size.

1.6 The solution

The two economies are assumed to be of the same size, initial wealth is equally distributed across countries, and asset markets are complete. Consequently, $\Lambda_t = s_t \Lambda_t^\star$, where Λ is the Langrange multiplier associated with the household's budget constraint. The model is solved by log-linearization around the deterministic steady state. For simplicity growth in the economy (real or nominal) is abstracted from and the price and output targets are set equal to their steady state levels[8]. Moreover, it is assumed that the two countries are perfectly symmetric. The structure of the shocks is as follows[9]:

The technology shock in each country follows the process[10]:

$$\log(A_t) = \rho_a \log(A_{t-1}) + (1 - \rho_a) \log(A) + \varepsilon_{at} \tag{12}$$

with $|\rho_a| < 1$ and ε_{at} $\mathcal{N}(0, \sigma_a)$.

The money demand shock follows:

$$\log(\zeta_t) = \rho_z \log(\zeta_{t-1}) + (1 - \rho_z) \log(\zeta) + \varepsilon_{zt} \tag{13}$$

with $|\rho_z| < 1$ and ε_{zt} $\mathcal{N}(0, \sigma_z)$.

And finally, the government spending shock is given by

$$\log(G_t) = \rho_g \log(G_{t-1}) + (1 - \rho_g) \log(G) + \varepsilon_{gt} \tag{14}$$

with $|\rho_g| < 1$ and ε_{gt} $\mathcal{N}(0, \sigma_g)$.

The model parameters are taken from Backus, Kehoe and Kydland, 1995 and Chari, Kehoe and McGrattan[11], 2002. Those of the interest rate rule are due to Taylor. The benchmark values are reported below.

In the steady state we have $P_x = P_x^* = P_c = P_c^* = P_H = P_H = s = 1$ and $R = R^\star = \frac{1}{\beta}$.

[8] There is no violation of the non-negative nominal interest rate restriction for the –small– shocks considered here.

[9] As Taylor (1993) remarks, "...policy evaluation results cannot be obtained from pure theoretical considerations. They depend on the empirical nature of the economic relations and on the size and correlation of the shocks to these relations..."

[10] Allowing for cross country correlation of the shocks is straightforward. While such correlation favors a fixed regime, the value used in the literature is too small to make much of a difference.

[11] These models differ somewhat from the model used here. One should then view these values as suggestive rather than as values selected to maximize the empirical fit of the particular model.

Table 1: Calibration

Discount factor	β	0.998
Relative risk aversion	σ	2.000
CES weight in utility function	ν	0.3301
Parameter of CES in utility function	η	-1.5641
Weight of money in the utility function	ζ	1e-06
Share of foreign goods in domestic intermediate good production	$1-s$	0.2000
Share of foreign goods in domestic consumption good production	$1-\omega$	0.2000
Substitution between domestic and foreign goods in consumption	ϕ	0.25
Substitution between domestic and foreign goods in production	ρ	0.25
Labor share	$1-\alpha$	0.65
Government spending as a share of GDP	g_y	0.2000
Persistence of technology shock	ρ_a	0.95
Volatility (sd) of technology shock	σ_a	0.008
Persistence of government spending shock	ρ_g	0.95
Volatility (sd) of government spending shock	σ_g	0.02
Persistence of money demand shock	ρ_ζ	0.95
Volatility (sd) of money demand shock	σ_ζ	0.016
Price coefficient in the HMT rule in t	K_p	1.50
Output gap coefficient in the HMT rule in t	K_y	0.5
Price coefficient in the HMT rule in $t-1$	K_{p1}	1.50
Output gap coefficient in the HMT rule in $t-1$	K_y	0.5

2 The results

The solution to the log-linearized model is used to compute the variance-covariance matrix of C, ℓ, M/P and ζ which is then used in a quadratic approximation of the utility function (the approximation is taken around the deterministic steady state). The rows in each welfare table (say, 2) report the level of welfare (in terms of steady state consumption) associated with each shock for each of the four monetary arrangements (for the parameter values reported in table 1). The volatility tables give the standard deviation of several important macroeconomic variables with all the shocks operating.

Several general patterns emerge. First, price rigidity is more costly than wage rigidity. This is true under all types of monetary policy exchange– rate regimes and shocks. Second, the type of "domestic" policy rule is more important than the flexibility of the exchange rate under supply shocks but less important under fiscal shocks. Third, differences in macroeconomic volatility are non-negligible across different monetary policies.

What is the relationship between the type of nominal friction, the degree of imperfect information and the performance of alternative exchange rate regimes? When the monetary authority can react to contemporaneous aggregate variables, then a flexible exchange rate system with activistic policy scores best under nominal price rigidity (table 2). This is the standard result in the literature. Under nominal wage rigidity the exact opposite pattern emerges. Namely, a passive (monetary targeting) rule under a fixed exchange rate regime fares the best. Hence, the popular presumption that has emerged in the recent literature in favor of the flexible exchange rate system may owe much to the assumption of price rigidity.

What is the intuition behind these results[12]? The results can be more easily understood by comparing the response of the economy under a particular nominal rigidity to the response that would have obtained under flexible prices. In the latter case, following a positive productivity shock both nominal prices and wages decrease (given the money supply), with wages decreasing less that prices in order to allow the real wage to rise with productivity. If prices are rigid, then following the supply shock the *value* of the marginal product of labor increases by more than under flexible prices, contributing to a larger increase in the demand for labor and employment relative to the efficient response. The

[12]Note that these welfare rankings reflect mostly supply shocks, which are the dominant source of volatility in our model. The rankings that arise from other shocks are also shown on the tables.

greater supply of domestic output leads to a domestic terms of trade deterioration. The deterioration requires a domestic nominal currency depreciation because goods prices are fixed. The depreciation in turn leads to higher domestic CPI prices (recall that prices are fixed in terms of the currency of the seller). Under the M-targeting rule, there is no policy response to these developments while under the interest rate rule, the policymakers react by raising interest rates (see the values of the interest rate row in table 6). The increase in the interest rate limits the excessive expansion in economic activity and employment that emanates from price rigidity, bringing them closer to the efficient levels. Thus, policy under an interest rate rule is conducted countercyclically with regard to the output gap (defined as actual minus flexible price output) and hence has stabilizing properties.

For exactly analogous reasons, the existence of nominal wage rigidity makes the response of the demand for labor and thus employment and output fall short of the efficient response (the nominal wage being too high). In the specification used here, this discrepancy is quite small (see table 8) which compares the efficient response to that under wage rigidity for alternative monetary arrangements). The positive domestic productivity shock raises output and lowers the price of the domestic intermediate good. The required domestic terms of trade deterioration is now accomplished partly via the reduction in the nominal price of the domestic good and partly via a domestic currency depreciation. In any case, the CPI decreases. Given the relative weighs in the interest rule, the domestic authorities loosen up, contributing to higher economic activity. As can be seen from table 8), even a modest policy response ($k_\pi = 1.5$) is sufficient to increase economic activity significantly, with employment and output overshooting the efficient levels considerably. Hence, although monetary policy is still conducted countercyclically with regard to the output gap, it has a destabilizing influence. As a result, a rigid rule performs better than the flexible, activistic one.

Why does the fixed regime fare better in this case? In order to gain intuition we can compare the two exchange rate systems under an interest rate rule. As explained above, under a flexible regime, the exchange rate depreciates while the nominal price of the good decrease. As the net effect of the supply shock on prices is negative, monetary policy is expansionary (table 7). Under a fixed regime, policy must prevent the exchange rate depreciation. This means that it cannot be as expansionary as under a flexible regime.

Hence, the existence of an exchange rate objective makes monetary policy less responsive to the output gap than under a flexible regime (see the previous paragraph).

Table 9 presents welfare comparisons associated with the case of greater imperfect information, that is when monetary policy can only react to macroeconomic developments with a lag[13]. As has been argued before in the Keynesian vs Monetarist debate, the presence of information lags works against policy activism. The fixed regime fares better than the flexible one because it requires –a small– domestic monetary contraction in order to prevent the depreciation of the domestic currency.

Two more findings are worth mentioning. First, the patterns established above are not much affected by the degree of trade in productive inputs. And second, these rankings are valid only when the supply shocks are the dominant source of economic (output) fluctuations. As can be seen from tables (2-4), the rankings are exactly reversed for fiscal shocks. That is, a global monetarist peg fares better under price rigidity while an interest rate rule, flexible regime performs relatively better when prices are rigid and information is very imperfect or when wages are rigid. Consequently, the overall welfare properties of alternative monetary arrangements depends very much on the relative importance of the various sources of macroeconomic volatility.

How robust are these rankings with regard to changes in the specification? We have solved the model under different assumptions about the type of policy rule pursued and obtained essentially the same results. For instance, using the domestic good price deflator in place of the CPI in the HMT rule (Tables 11-12), as is common practice in the literature, improves the performance of the HMT rule under *rigid* prices but does not change any of the conclusions reached above. Similarly, having the monetary authorities respond to deviations of output from the flexible price level rather than from the steady state value again makes the HMT more attractive but does not change the main results (Tables 13-14). The rankings are also robust to changes in other parameter values. For instance, to changes in the degree of openness, in the elasticity of substitution between domestic and foreign goods[14], in the relative weighs of output and prices in the interest policy rule, in the weigh of real balances in the utility function and so on.

[13]We do not report results for the case of a fixed exchange rate regime with an interest rate rule because this specification leads to indeterminacy.

[14]Increasing the value of the elasticity of substitution and/or also making the supply shock less persistent (thus increasing the strength of substitution effects) worsens the performance of the interest rate rule under flexible exchange rates, making M-targeting perform better even in this case.

A possible limitation of the model is that it postulates a very rigid form of nominal frictions. Namely, that all prices or wages are predetermined for exactly one period. This has two disadvntages¿ First, there can be no –even partial– price adjustment when the shock hits. And second, there is no persistence in price setting behaviour. Most of the literature has relied on price adjustment mechanisms in which some immediate, partial price adjustment to shocks is feasible and also nominal rigidity persists for more than one period. While a priori, there is no reason to believe that such schemes will improve the performance of the HMT rule under wage rigidity (for the reasons detailed by Erceg, Henderson and Levin, 1999) I have also carried the analysis under price and wage adjustment costs in the popular, imperfectly competitive, new Keynesian model. Moreover, to address the concerns regarding the dangers of using a second order approximation to welfare when the model has only been solved at a first order (Woodford, 2003, Sutherland, 2002, and others), the model was solved at the second order. The description of the expanded model and the main results can be found in a technical appendix to this paper $http://www.vwi.unibe.ch/amakro/resear/resea_e.htm$. It turns out that the superiority of monetary targeting and the good performance of the fixed exchange rate regime survive this change in specification and solution method.

3 Conclusions

The recent literature on the welfare properties of alternative exchange rate regimes typically comes out in favor of activistic monetary policy and flexible exchange rates. This paper examines the extent to which this result may hinge on three commonly made assumptions. First, that the monetary authorities know a lot about the state of the economy (that is, that they can perfectly observe and react to current shocks). Second, that prices (rather than wages) are the source of nominal rigidity. And third, that there is no direct international trade production interdependence. The first assumption induces a bias in favor of activistic policies. As the flexible exchange rate system is more suitable to the pursuit of activistic policies, it also induces a bias in favor of it. The second assumption also introduces a bias in favor of flexible exchange rates as it implies that the nominal exchange rate is the the only means for bringing about needed terms of trade changes.

It turns out that indeed the type of nominal rigidity and the degree of imperfect

information play a key role in the ranking of alternative monetary policy arrangements. Good information and price rigidity may support a flexible exchange rate system and activistic policy while wage rigidity and limited information favor simpler targeting procedures, such as the targeting of the money supply or the exchange rate. Nevertheless, the case for a Taylor type rule and a flexible regime under *fixed prices* is not completely undermined by the lack of perfect information on the part of the monetary authorities, as long as information is not too imperfect. And neither is it undermined when production trade interdependence is present.

These findings may have also something to say about the conditions under which international policy coordination could prove beneficial. Unsurprisingly, international policy coordination does not help when policy activism performs well. More interestingly, a simple form of international policy coordination (a global monetary targeting rule) seems desirable in situations in which rigid policies fare well.

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Table 2: Welfare comparisons: Price rigidity

shock	FLEX-M	FLEX-R	FIX-M	FIX-R
Supply	-0.027531	-0.024821	-0.028512	-0.025831
Fiscal	-0.008981	-0.008273	-0.008202	-0.008883
Money	-0.000296	-0.000005	-0.000148	-0.000005
All	-0.036805	-0.033097	-0.036860	-0.034717

Note: Each entry gives the level of welfare for each shock, in terms of the corresponding steady state consumption equivalent of the cost of fluctuations. FLEX-M, FLEX-R, FIX-M,FIX-R correspond to a flexible exchange rate regime with money targeting, flexible regime with an interest rate rule, fixed exchange rate regime with –world– money targeting and a fixed exchange rate regime with an interest rate rule respectively.

Table 3: Macroeconomic volatility: All shocks, price rigidity

	FLEX-M	FLEX-R	FIX-M	FIX-R
y	4.16	3.98	4.19	4.10
h	1.63	1.58	1.63	1.61
p	4.79	1.43	4.81	2.25
q	6.83	6.65	6.92	6.92
p_h	5.49	2.57	5.55	3.57

Note: Standard deviation of output, y, employment, h, CPI, p, terms of trade, q, and and domestic price level, p_h.

Table 4: Welfare comparisons: Wage rigidity

shock	FLEX-M	FLEX-R	FIX-M	FIX-R
Supply	-0.022117	-0.022611	-0.022044	-0.022699
Fiscal	-0.008388	-0.008177	-0.008429	-0.008439
Money	-0.000076	-0.000005	-0.000020	-0.000005
All	-0.030579	-0.030791	-0.030491	-0.031141

Note: Each entry gives the level of welfare for each shock, in terms of the corresponding steady state consumption equivalent of the cost of fluctuations.

Table 5: Macroeconomic volatility: All shocks, wage rigidity

	FLEX-M	FLEX-R	FIX-M	FIX-R
y	3.35	3.49	3.34	3.48
h	1.68	1.59	1.68	1.63
p	4.06	1.26	4.07	1.77
q	5.10	5.20	5.08	5.08
p_h	4.51	2.03	4.55	2.70

Note: Standard deviation of output, y, employment, h, CPI, p, terms of trade, q, and domestic price level, p_h.

Table 6: Elasticities, price rigidity

var	FLEX-M	FLEX-R	FIX-M	FIX-R
y	1.520956	1.249623	1.536652	1.347345
c	0.330220	0.664009	0.323594	0.552987
h	0.801471	0.384036	0.825618	0.534377
p	0.011939	0.011012	-0.000000	-0.000000
q	0.059695	0.055059	-0.000000	0.000000
R	0.010639	0.641329	0.006004	0.554417

Note: Each entry gives the impact effect of a domestic supply shock on output, y, employment, h, CPI, p, terms of trade, q, and domestic nominal interest rate, R.

Table 7: Elasticities, wage rigidity

var	FLEX-M	FLEX-R	FIX-M	FIX-R
y	0.776235	1.405488	0.756079	1.300380
c	0.739198	1.604097	0.720834	1.515309
h	-0.344255	0.623827	-0.375262	0.462123
p	-0.903971	-0.524236	-0.922651	-0.629565
q	1.082590	1.287121	1.043454	1.043459
R	-0.005123	-0.083610	-0.003839	-0.108847

Note: Each entry gives the impact effect of a domestic supply shock on output, y, employment, h, CPI, p, terms of trade, q, and the nominal interest rate, R.

Table 8: Elasticities, wage rigidity, comparison to the efficient response

var	Efficient	FLEX-M	FLEX-R	FIX-M	FIX-R
y	0.8976	0.776235	1.405488	0.756079	1.300380
c	0.9044	0.739198	1.604097	0.720834	1.515309
h	-0.1576	-0.344255	0.623827	-0.375262	0.462123

Note: Each entry gives the impact effect of a positive, domestic supply shock on output, y, employment, h, and consumption, c.

Table 9: Welfare comparisons: Price rigidity, lagged monetary response

shock	FLEX-M	FLEX-R	FIX-M	FIX-R
Supply	-0.022117	-0.022545	-0.022044	-0.022044
Fiscal	-0.008388	-0.008244	-0.008429	-0.008429
Money	-0.000076	-0.000005	-0.000020	-0.000020
All	-0.030579	-0.030793	-0.030491	-0.030491

Note: Each entry gives the level of welfare for each shock, in terms of the corresponding steady state consumption equivalent of the cost of fluctuations.

Table 10: Macroeconomic volatility: All shocks, price rigidity, lagged monetary response

	FLEX-M	FLEX-R	FIX-M	FIX-R
y	3.35	3.48	3.34	3.34
h	1.68	1.58	1.68	1.68
p	4.06	1.26	4.07	4.07
q	5.10	5.20	5.08	5.08
ph	4.51	2.03	4.55	4.55

Note: Standard deviation of output, y, employment, h, CPI, p, terms of trade, q, and domestic price level, p_h.

Alternative monetary policy rules

Table 11: Welfare comparisons: Price rigidity, domestic price targeting

shock	FLEX-M	FLEX-R	FIX-M	FIX-R
Supply	-0.027531	-0.023260	-0.028512	-0.025831
Fiscal	-0.008981	-0.008257	-0.008202	-0.008883
Money	-0.000296	-0.000005	-0.000148	-0.000005
All	-0.036805	-0.031521	-0.036860	-0.034717

Note: Each entry gives the level of welfare for each shock, in terms of the corresponding steady state consumption equivalent of the cost of fluctuations.

Table 12: Welfare comparisons: Wage rigidity, domestic price targeting

shock	FLEX-M	FLEX-R	FIX-M	FIX-R
Supply	-0.022117	-0.022686	-0.022044	-0.022699
Fiscal	-0.008388	-0.008103	-0.008429	-0.008439
Money	-0.000076	-0.000005	-0.000020	-0.000005
All	-0.030579	-0.030793	-0.030491	-0.031141

Note: Each entry gives the level of welfare for each shock, in terms of the corresponding steady state consumption equivalent of the cost of fluctuations.

Table 13: Welfare comparisons: Fixed prices, flexible price output gap targeting

shock	FLEX-M	FLEX-R	FIX-M	FIX-R
Supply	-0.027531	-0.022747	-0.028512	-0.023785
Fiscal	-0.008981	-0.008283	-0.008202	-0.008400
Money	-0.000296	-0.000005	-0.000148	-0.000005
All	-0.036805	-0.031033	-0.036860	-0.032188

Note: Each entry gives the level of welfare for each shock, in terms of the corresponding steady state consumption equivalent of the cost of fluctuations.

Table 14: Welfare comparisons: Fixed wages, flexible price output gap targeting

shock	FLEX-M	FLEX-R	FIX-M	FIX-R
Supply	-0.022117	-0.023051	-0.022044	-0.023099
Fiscal	-0.008388	-0.008213	-0.008429	-0.008400
Money	-0.000076	-0.000005	-0.000020	-0.000005
All	-0.030579	-0.031267	-0.030491	-0.031502

Note: Each entry gives the level of welfare for each shock, in terms of the corresponding steady state consumption equivalent of the cost of fluctuations.