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Working Paper
Number UT-ECIPA-Floyd-96-01

**Stochastic Monetary Interdependence: The Case for
Flexible Exchange Rates Revisited**

by

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January 8, 1996

Latest Version: January 8, 1996

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ISSN 0829-4909

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On-line Version: <http://www.epas.utoronto.ca:5680/wpa/wpa.html>

ABSTRACT

A theory is developed to explain the following two stylized facts now well known to international economists: first, countries' real and nominal exchange rates tend to move together under flexible exchange rate systems with the ratios of domestic to rest-of-world price levels showing much less variability; and second, business cycles and medium-term price level movements tend to be international in scope. It ascribes these phenomena to the maximizing behavior of central banks, each pursuing similar objectives, in a world where information about the future course of economic activity and the timing of the influence of central bank policy upon it is extremely poor. It shows how central banks, given the limited information available to them, are induced to set a path of monetary growth that will neutralize the effects of international portfolio shocks on the exchange rate, while allowing movements in exchange rates that result from changes in technology, oil shocks, the terms of trade and other real forces to go through unopposed. The result is a similarity of credit conditions across countries leading to world-wide variations of outputs and inflation rates. The theory also explains important details regarding the functioning of foreign exchange markets, as well as the conditions under which countries will chose flexible exchange rates rather than fixed rates. This gives a new perspective on the old question of whether fixed or flexible exchange rates are the best regime and brings us a bit closer to a theory of optimal currency areas.

Stochastic Monetary Interdependence: The Case for Flexible Exchange Rates Revisited

John E. Floyd
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This paper develops a theory that explains important stylized facts now well known to international economists: first, countries' real and nominal exchange rates tend to move together under flexible exchange rate systems with the ratios of domestic to rest of the world price levels showing much less variability [Mussa (1979)]; second, business cycles and medium-term price level movements tend to be international in scope [Burns and Mitchell (1941); Zarnowitz (1985); Backus, Keyhoe and Kydland (1991)]. These phenomena are ascribed to the maximizing behavior of central banks, each pursuing similar objectives, in a world where information about the future course of economic activity and the timing of the influence of central bank policy upon it is extremely poor. Central banks, given the limited information available to them, are induced to set a path of monetary growth that will neutralize the effects of international portfolio shocks on the exchange rate, while allowing movements in exchange rates that result from changes in technology, oil shocks, the terms of trade, and other real forces to go through unopposed. The result is a similarity of credit conditions across countries leading to world-wide variations of outputs and inflation rates. This monetary coordination across countries in response to exogenous local and world-wide stochastic shocks suggests an appropriate name for the theory: *Stochastic Monetary Interdependence*.

* Revised January 8, 1996. This research was financed in part by the Social Sciences and Humanities Research Council of Canada and some of the early work was completed while I was Visiting Fellow at the Australian National University. I would like to thank Jack Carr, Trevor Dick, Miguel Faig, Bob Gregory, Fred Gruen, Allan Hynes, John Johnston, Yehuda Kotowitz, Halina Kwiecinska, Angelo Melino, Mike Peters, Kit Pasula, Peter Pauly, Myrna Wooders and the late Douglas Purvis for helpful discussions.

In providing a coherent explanation of how world monetary policy works, both money shocks and speculative bubbles are ruled out as factors explaining recent major (though not minor) real exchange rate movements. The results indicate why purchasing power parity has not been a useful empirical model of exchange rate behavior [Meese and Rogoff, 1983] and explain the tendency of forward exchange rates to grossly underpredict and often wrongly predict the future movements in spot rates [Mussa, 1979]. Finally, a new perspective is presented on the old question of whether fixed or flexible exchange rate systems are best by establishing the circumstances under which it will pay a country to adopt one regime rather than the other. This brings us a bit closer to a theory of optimal currency areas.

The results developed here are in sharp contrast with the recent literature on the international coordination of economic policies [Oudiz and Sachs, 1984; Canzoneri and Henderson, 1991]. That literature explores the logical consequences of maximizing behavior of individual countries' authorities when they know the parameters governing the time paths of their economies and concludes that substantive attempts at coordination are rare; this paper explores the consequences when the maximizing authorities know the signs but not the magnitudes of the parameters and cannot forecast dynamic paths, and suggests that coordination is inadvertent but widespread. This difference in the assumed information sets of the authorities also distinguishes this present work from the targets and indicators literature [Brainard, 1967; Poole, 1970; Turnovsky, 1976; Boyer, 1978; Weber, 1981].

Some Facts to be Explained

The real and nominal exchange rates and domestic/foreign price level ratios of nine industrial countries are plotted in Figure 1 (see page 30) . For each country, the ratio of the domestic price level to the price level in the rest of the world is indicated by the thick solid line, and the real and nominal exchange rates by the thin solid and broken lines. The rest-of-world aggregate consists of the remaining eight countries.¹ The correspondence of the real and nominal exchange rate movements and the high degree of both high and low frequency exchange rate as compared to price level variability is immediately evident.²

¹ The price levels are consumer price indexes with the rest-of-world price level being an index of all other countries' CPI's using 1980 output shares as weights. The real exchange rate is the ratio of the domestic CPI to a 1980 output-weighted average of the CPI's of all other countries after all CPI's have been multiplied by the U.S. dollar prices of the individual countries' currencies.

² This stylized fact as well as others of interest here were noted in Mussa's (1979) excellent wide-ranging summary of the character of real exchange rate movements. A more recent study

There is also well-substantiated evidence that the business cycle is international in scope. Backus, Kehoe and Kydland (1991) calculate the contemporaneous correlations of the logarithms of outputs of a number of countries with the logarithm of U.S. output after detrending the output variables using the Hodrick-Prescott technique.³ The cross-correlations for a selected group of countries are as follows:

Australia	.25	Austria	.31
Canada	.77	Finland	.02
France	.22	Germany	.42
Italy	.39	Japan	.25
Switzerland	.27	United Kingdom	.48
Europe	.70		

Contemporaneous correlations are not the best indication of the international scope of business cycle activity because they do not take account of differences in timing across countries and regions. In a spectral analysis of the GNP series of the U.S., U.K., Germany and Japan, Dellas (1986) found the following pairwise coherence coefficients:⁴

U.S.-Germany	0.9 at 2.5 years
U.S.-U.K.	0.7 at 9 quarters
U.S.-Japan	0.55 at 4 years
U.K.-Germany	0.6 at 2.5 to 4 years
U.K.-Japan	0.5 at 5 years
Germany-Japan	0.7 at 3.5 years

Gerlach (1988) also finds that the output movements of a group of countries—Belgium, Canada, France, Germany, Italy, Netherlands, Norway, and Sweden—are correlated in the business cycle frequency band.

The inflation rates of the major industrial countries during the past three decades are shown in Figure 2 (see page 31) . They all show the same general pattern—low inflation

by De Grauwe, Jansens and Leliaert (1985) finds the same thing.

³ The Hodrick-Prescott filter removes low-frequency variations from the data, acting as a flexible detrending procedure. For discussions of the technique, see Hodrick and Prescott (1980), King and Rebelo (1989) and Kydland and Prescott (1990).

⁴ The coherence coefficient indicates the proportion of the variance of one economic series that is accounted for by variation in another series at some frequency.

during the 1960s, higher rates during the 1970s with peaks around 1973 and 1979, and declines during the 1980s toward the levels experienced in the 1960s. Within this pattern, there were differences both in variability and level between countries. The inflation rates of the U.K., France, Italy and Australia tended to rise a lot during the 1970s, those of Germany and Austria rose by much less, and U.S. and Canadian inflation rates occupied a middle position. The differences in variability indicate that as business cycles and trend shifts in income and money growth occurred the different countries experienced different timing and amplitude of price level adjustments. The simple correlations between the U.S. inflation rate and those of the other countries are given below:

United Kingdom	.74	Japan	.45
Germany	.58	Canada	.83
France	.79	Austria	.51
Italy	.72	Australia	.63

These facts raise the question of whether the long-touted benefits of flexible exchange rates in allowing countries to pursue independent countercyclical policies are being taken advantage of. If countries were pursuing independent policies, one might expect important differences in cyclical behavior across countries together with real exchange rate movements that reflect attempts to pursue monetary and fiscal independence and that are ultimately transmitted to domestic employment and prices. Moreover, one would observe differences in the behavior of real macroeconomic aggregates such as output, consumption, and investment in flexible as opposed to fixed exchange rate regimes. Nevertheless, there appears to be little difference in cyclical behavior across regimes [Baxter and Stockman (1989)].

Some Initial Assumptions

Three kinds of assumptions are necessary to set the stage: assumptions dealing with the structure of the world economy and the exogenous shocks affecting it, assumptions about the information sets of public and private agents, and institutional assumptions about the way private agents and the authorities adapt to stochastic shocks.

Economic Structure and Exogenous Shocks

- The world consists of two countries, labeled domestic and foreign, with the domestic economy being small in relation to the rest of the world.
- The full-employment output levels of both countries vary stochastically around deterministic trends that may shift from time to time. The relative price of domestic output in

terms of foreign output at full employment, defined as the *natural real exchange rate*, is indistinguishable from a random walk.

- Claims to capital employed in the two economies can be freely exchanged internationally and agents in both countries hold home-denominated money balances, the desired real holdings of which are negatively related to the interest rate in the usual fashion.
- The demand for money in each country varies stochastically around a deterministic trend that may shift from time to time.

Information Sets

- Agents do not observe the exogenous stochastic output, real exchange rate and demand for money shocks. Nor do they immediately observe trend shifts in output and the demand for money. Eventually, however, they acquire correct knowledge both of the variances of the shocks and the trends around which they occur.
- Agents have good information about prices in their own industries but do not observe the general level of prices within period.
- Nominal interest rates and the nominal exchange rate are observed within period but real interest rates and the real exchange rate are not.
- Agents observe the quantity of money within period but are unable to determine whether observed changes in the money supply are exogenous supply shocks or endogenous responses of the monetary authority to changes in the demand for money.
- Central banks, like the private agents in the financial sector, have some within-period information about monetary conditions that arises from knowledge of “their own” industry. Private agents lack direct knowledge of the central bank’s market intervention plans.
- Private agents and the authorities have good information about the signs of the structural parameters in the economy. But they have insufficient information about the magnitudes of these parameters and the learning responses of other agents to predict the dynamic response path of the economy to the exogenous technology, real exchange rate, and demand for money shocks. The authorities therefore do not have sufficient information predict the timing of the future quantitative impact of current unanticipated (by the private sector) exogenous shocks to the money supply.

Institutional Setting

- The supply of money in each country expands at the discretion of that country's authorities subject to political pressures to keep the average rate of money growth consistent with a social consensus about the fraction of government expenditure that will be money financed and the corresponding inflation tax on real money holdings. This consensus together with the technology and informational assumptions above implies an inflation rate about which agents eventually form correct expectations.
- There exists a forward exchange market in which the forward discount on domestic currency is equal to the excess of the domestic nominal interest rate over the foreign nominal rate and reflects a risk premium plus the expected rate of depreciation of the domestic currency between this period and next. The domestic and foreign real interest rates therefore differ by the aforementioned risk premium plus the expected rate of depreciation of the real exchange rate, which turns out to be zero under the above assumptions.
- Unanticipated deviations of the price level from values based on past realizations and the current expected inflation rate lead to deviations of the unemployment rate from its natural level in the opposite direction. Anticipated changes in the money supply have no effects on agents' decisions about real variables.
- Although the exogenous shocks to technology, the natural real exchange rate and the demand for money are not serially correlated, the structural and informational assumptions do not rule out the possibility that, due to time-to build, wage contracts, etc., movements of output and employment away from their natural levels will be serially correlated. They do rule out any possibility that private agents or the authorities can successfully forecast the time paths of these variables.

All of these assumptions are conventional apart from the assumed predictive impotence of economists, which some may find discomfiting.⁵ The latter assumption means that central banks cannot determine the timing of the future response of the economy to current policy initiatives—they can construct dynamic path models but have insufficient parameter information to choose one such model over another. This severely limits their discretionary policy options. Changes in the structural parameters across policy regimes are of no consequence for policy formulation, as long as the signs don't change, because the authorities have insufficient knowledge of the magnitudes of these parameters in any case. It nevertheless turns out

⁵ For evidence on economists' forecasting ability, see McNees (1979), Kenen and Schwartz (1986), Zarnowitz (1984) and Mankiw and Shapiro (1986).

that minimizing the variance of the current period shocks to the price level will minimize the variance of unemployment.

The Model

The analysis here focuses entirely on the problem of a small country that faces domestic technology and demand for money shocks and operates in an international economy in which there are also technology, demand for money, and supply of money shocks. In a world consisting entirely of small countries that do not cooperate explicitly in the setting of monetary policy, the solution of the individual country's policy problem defines world monetary policy.

Along the path on which full employment is continually maintained, the foreign economy produces θ_t^* units of a single world consumption characteristic and the domestic economy $\vartheta_t\theta_t$ units, where θ_t is the domestic output aggregate and ϑ_t , the natural real exchange rate, is the number of units of the world consumption characteristic yielded by each unit of domestic output. θ_t and θ_t^* are henceforth referred to as the natural levels of domestic and foreign outputs. ϑ_t is a random walk, determined by both technology and tastes. The natural riskless real interest rate on securities denominated in the world consumption characteristic, ρ_t^* , is determined by rest-of-the-world technology and related both to θ_t^* and to a stochastic shift variable ϕ_t . The stochastic deviations of θ_t , θ_t^* and ϕ_t from their trends, taken as proportions of trend levels, have zero means and constant variances, as do the innovations to ϑ_t .

The demand functions for money are standard with everything but interest rates expressed in logarithms.

$$P_t = M_t - \gamma_t + \eta r_t + \eta (E_{t-1}P_{t+1} - E_{t-1}P_t) - \epsilon Y_t \quad (1)$$

$$P_t^* = M_t^* - \gamma_t^* + \eta^* r_t^* + \eta^* (E_{t-1}P_{t+1}^* - E_{t-1}P_t^*) - \epsilon^* Y_t^* \quad (2)$$

where P_t is the price level, M_t is the nominal money stock, r_t is the real interest rate, Y_t is the level of output, γ_t is a shift variable and E_{t-1} is the expectations operator based on the information available in period $t - 1$. The superscript $*$ indicates that the parameter or variable applies to the rest of the world.

Outputs are determined by short-run aggregate supply curves of the form

$$Y_t = \theta_t + \lambda (P_t - E_{t-1}P_t) + \psi (Y_{t-1} - \theta_{t-1}) \quad (3)$$

$$Y_t^* = \theta_t^* + \lambda^* (P_t^* - E_{t-1}P_t^*) + \psi^* (Y_{t-1}^* - \theta_{t-1}^*) \quad (4)$$

Since agents use all available information in setting prices, the expected price levels are those that will produce full employment if information about money, technology and other exogenous variables turns out to be correct. Output deviates from its natural level when price

level surprises occur.⁶ The inclusion of the lagged deviation of output from its natural level introduces some rudimentary dynamics. Current output will be affected by past price-level surprises on account of irreversible past investment decisions based on them. Also, wage settings may be locked into contracts written in previous periods so that the unemployment rate will vary persistently even though previous periods' price levels are observed by agents. The parameters in the model, especially λ and λ^* , will not be constant across different monetary regimes because agents' information about the variance of unexpected price level shocks will affect their behavior [Lucas, 1973]. Given our information assumptions, however, the authorities have insufficient knowledge of the magnitudes of the parameters and the learning process that causes them to change to motivate discretionary policy initiatives.

The market real exchange rate is defined as

$$q_t = P_t - P_t^* - \Pi_t \tag{5}$$

where q_t is the market real exchange rate and Π_t is the nominal exchange rate (domestic currency price of foreign currency).

The market real exchange rate is determined according to

$$q_t = \vartheta_t - \sigma[\lambda(Y_t - \theta_t) - \lambda^*(Y_t^* - \theta_t^*)]. \tag{6}$$

It equals the natural real exchange rate when output is at its natural level—the relative valuation of the two countries' outputs is then given by the technology and tastes. When domestic output rises relative to rest-of-the-world output at given technology and tastes, the marginal valuation of domestic output in producing the world consumption characteristic declines, reducing the real exchange rate.

Since each country's securities are denominated in their own output goods, the domestic riskless real interest rate differs from the foreign riskless real rate by the expected rate of change in the real exchange rate. The latter turns out to be zero, given the random walk nature of the natural real exchange rate and agents' lack of information about the structural parameters. Hence,

$$r_t = r_t^*. \tag{7}$$

⁶ It makes no difference here whether the output and employment fluctuations result from errors in wage setting that lead to “involuntary unemployment” or from the misperception that real wages have temporarily changed when they have not, leading to “voluntary” substitution between current and future leisure.

Finally, the natural and market real interest rates in the rest of the world are determined according to

$$\rho_t^* = \Phi^* \theta_t^* + \phi_t \quad (8)$$

$$r_t^* = \Phi^* Y_t^* + \phi_t. \quad (9)$$

so that

$$r_t^* - \rho_t^* = \Phi^*(Y_t^* - \theta_t^*) \quad (10)$$

All parameters in the above equations with the exception of Φ^* are positive—the latter can take either sign.⁷

The above relationships can be consolidated into a four-equation system. Substituting (3) into (1) and (4) into (2) and utilizing (7), we obtain

$$\begin{aligned} P_t = M_t - \gamma_t + \eta r_t^* + \eta (E_{t-1} P_{t+1} - E_{t-1} P_t) - \epsilon \theta_t - \epsilon \lambda (P_t - E_{t-1} P_t) \\ - \epsilon \psi (Y_{t-1} - \theta_{t-1}) \end{aligned} \quad (11)$$

$$\begin{aligned} P_t^* = M_t^* - \gamma_t^* + \eta^* r_t^* + \eta^* (E_{t-1} P_{t+1}^* - E_{t-1} P_t^*) - \epsilon^* \theta_t^* - \epsilon^* \lambda^* (P_t^* - E_{t-1} P_t^*) \\ - \epsilon^* \psi^* (Y_{t-1}^* - \theta_{t-1}^*). \end{aligned} \quad (12)$$

Rearranging (5) and substituting in (6), (3) and (4) we obtain

$$\begin{aligned} \Pi_t = P_t - P_t^* - \vartheta_t + \sigma [\lambda (P_t - E_{t-1} P_t) - \lambda^* (P_t^* - E_{t-1} P_t^*)] \\ + \sigma [\psi (Y_{t-1} - \theta_{t-1}) - \psi^* (Y_{t-1}^* - \theta_{t-1}^*)]. \end{aligned} \quad (13)$$

⁷ Equation (6) can be manipulated into the form

$$(Y_t - \theta_t) = -\frac{1}{\sigma \lambda} (q_t - \vartheta_t) + (Y_t^* - \theta_t^*) \quad (6')$$

and (10) can be rearranged as

$$(Y_t^* - \theta_t^*) = \frac{1}{\Phi^*} (r_t^* - \rho_t^*) \quad (10')$$

These equations can be viewed as counterparts to the standard *IS* relationships modified so that changes in the world interest rate do not *differentially* affect domestic and rest-of-world aggregate demand. Adding an interest rate term to (6') and modifying (6) accordingly increases the complexity of the model but does not affect the results. A much more extensive treatment of these issues is contained in a working paper available from the author on request.

Finally, substitution of (4) and (7) into (9) yields

$$r_t^* = \Phi^* \theta_t^* + \Phi^* \lambda^* (P_t^* - E_{t-1} P_{et}^*) + \Phi^* \psi^* (Y_{t-1}^* - \theta_{t-1}^*) + \phi_t. \quad (14)$$

A system of four equations determining the expected levels of P_t , P_t^* , Π_t , and r_t^* can now be obtained by passing the expectations operator through equations (11)–(14):

$$\begin{aligned} E_{t-1} P_t &= E_{t-1} M_t - E_{t-1} \gamma_t + \eta E_{t-1} r_t^* + \eta (E_{t-1} P_{t+1} - E_{t-1} P_t) \\ &\quad - \epsilon E_{t-1} \theta_t - \epsilon \psi (Y_{t-1} - \theta_{t-1}) \end{aligned} \quad (15)$$

$$\begin{aligned} E_{t-1} P_t^* &= E_{t-1} M_t^* - E_{t-1} \gamma_t^* + \eta^* E_{t-1} r_t^* + \eta^* (E_{t-1} P_{t+1}^* - E_{t-1} P_t^*) \\ &\quad - \epsilon^* E_{t-1} \theta_t^* - \epsilon^* \psi^* (Y_{t-1}^* - \theta_{t-1}^*). \end{aligned} \quad (16)$$

$$\begin{aligned} E_{t-1} \Pi_t &= E_{t-1} P_t - E_{t-1} P_t^* - E_{t-1} \vartheta_t \\ &\quad + \sigma [\psi (Y_{t-1} - \theta_{t-1}) - \psi^* (Y_{t-1}^* - \theta_{t-1}^*)]. \end{aligned} \quad (17)$$

$$E_{t-1} r_t^* = \Phi^* E_{t-1} \theta_t^* + \Phi^* \psi^* (Y_{t-1}^* - \theta_{t-1}^*) + E_{t-1} \phi_t. \quad (18)$$

Let $DX_t (= X_t - E_{t-1} X_t)$ be the current-period deviation of the variable X from its expected level. For those variables expressed in logarithms, this is equivalent to expressing the deviations as percentages of expected levels. For r_t , r_t^* , E_{pt} , E_{p^*t} and E_{qt} , the deviations are expressed in percentage points.

Subtracting (15), (16), (17) and (18) from (11), (12), (13), and (14) respectively, we obtain the following equations determining the equilibrium unanticipated shocks to the system:

$$DP_t = \frac{1}{1 + \epsilon \lambda} DM_t - \frac{1}{1 + \epsilon \lambda} D\gamma_t + \frac{\eta}{1 + \epsilon \lambda} Dr_t^* - \frac{\epsilon}{1 + \epsilon \lambda} D\theta_t \quad (19)$$

$$DP_t^* = \frac{1}{1 + \epsilon^* \lambda^*} DM_t^* - \frac{1}{1 + \epsilon^* \lambda^*} D\gamma_t^* + \frac{\eta^*}{1 + \epsilon^* \lambda^*} Dr_t^* - \frac{\epsilon^*}{1 + \epsilon^* \lambda^*} D\theta_t^* \quad (20)$$

$$D\Pi_t = -D\vartheta_t + (1 + \sigma \lambda) DP_t - (1 + \sigma \lambda^*) DP_t^* \quad (21)$$

$$Dr_t^* = \Phi^* D\theta_t^* + \Phi^* \lambda^* DP_t^* + D\phi_t \quad (22)$$

The interpretation of these equations is straight forward. In (19) and (20) unanticipated increases in the nominal money stock or decreases in the demand for money unexpectedly raise the price level. An unanticipated rise in the world interest rate reduces the demand for money, unexpectedly raising both price levels. Unanticipated positive output-technology shocks increase the demand for money, unexpectedly lowering the price level. Unanticipated

shocks to the natural real exchange rate are transmitted directly to the nominal exchange rate in (21) and shocks to the domestic and foreign price levels have two effects—they affect the nominal exchange rate directly at each level of the real exchange rate and they create deviations of the real exchange rate from its natural level by changing the relative domestic and foreign output levels at given technology and tastes. In (22), unanticipated shocks to the rest-of-the-world real interest rate arise either directly or from technology and employment shocks to world output.

Monetary Policy and the Choice of Exchange Rate Regime

An “ideal” or “perfect” monetary policy would be one where the authorities instantaneously adjust the nominal money supplies to the quantities demanded at the current states of technology and demand for money and the current expected price level. Private wage and price settings then turn out to be equilibrium settings and no unemployment results. To implement an ideal policy, the authorities would have to observe all domestic and foreign stochastic technology and demand for money shocks as well as the structural parameters of both the domestic and foreign economies. Since lack of information rules out such discretionary policies, it is natural that the authorities look for procedures or “rules of thumb” that will help formulate a coherent policy. Two immediately obvious rules of thumb are to fix the exchange rate or, alternatively, to try to maintain a constant rate of domestic money growth and let the exchange rate float freely. The central bank, knowing nothing more than the signs of the structural parameters, has to act as if these parameters are the same across regimes.

The implications of fixed exchange rates (as viewed by the central bank) are seen by setting $D\Pi_t = 0$ in (21) and rearranging that expression to obtain

$$DP_t = \frac{1}{1 + \sigma\lambda} D\vartheta_t + DP_t^* \quad (23)$$

where, to simplify, $\lambda = \lambda^*$. DP_t^* is obtained by substituting (22) into (20):

$$DP_t^* = \frac{1}{1 + (\epsilon^* - \eta^*\Phi^*)\lambda^*} [DM_t^* - D\gamma_t^*] - \frac{\epsilon^* - \eta^*\Phi^*}{1 + (\epsilon^* - \eta^*\Phi^*)\lambda^*} D\theta_t^* + \frac{\eta^*}{1 + (\epsilon^* - \eta^*\Phi^*)\lambda^*} D\phi_t \quad (24)$$

Shocks to the natural real exchange rate pass directly onto the domestic price level. When there are no shocks to the natural real exchange rate, fixing the nominal rate leads to unanticipated domestic price level shocks identical to those in the rest of the world. Exogenous unanticipated shocks to the domestic exogenous variables have no effect on the price level—their effects are eliminated by endogenous adjustments of the domestic nominal money stock. The magnitude

of these portfolio adjustments can be obtained by substituting (22), (23) and (24) into (19) to eliminate DP_t , and solving for DM_t .

The unanticipated domestic price level shocks under flexible exchange rates are determined by (19). Apart from the influence of unanticipated changes in the rest-of-world interest rate, Dr_t^* , they are determined entirely by exogenous shocks to the supply and demand for nominal money balances in the domestic economy, with the demand for money shocks arising from shocks to the natural level of output and/or the demand function for money. The nominal exchange rate adjusts in (21) in response to the domestic and rest-of-world unanticipated price level shocks and shocks to the natural real exchange rate. This reaffirms the well-known result that flexible exchange rates insulate the domestic economy from foreign price level and real income shocks as well as natural real exchange rate shocks, but not from shocks to world interest rates. The shock to the rest-of-world real interest rate is obtained by substituting (24) into (22):

$$Dr_t^* = \frac{\lambda^* \Phi^*}{1 + (\epsilon^* - \eta^* \Phi^*) \lambda^*} [DM_t^* - D\gamma_t^*] + \frac{\Phi^*}{1 + (\epsilon^* - \eta^* \Phi^*) \lambda^*} D\theta_t^* + \frac{1 + \lambda^* \epsilon^*}{1 + (\epsilon^* - \eta^* \Phi^*) \lambda^*} D\phi_t \quad (25)$$

Under flexible exchange rates with constant money growth both in the domestic economy and abroad (where the rest of the world is an aggregate of numerous countries structurally identical to the domestic one) the variance of the unanticipated shocks to the domestic price level can be greater or less than the variance of the unanticipated shocks to the price level in the rest of the world. This will depend on whether the unanticipated shocks to the domestic demand for money, given by the terms on the right-hand side of (19), have greater variance than the unanticipated shocks to the rest-of-world demand for money, given by the corresponding terms on the right-hand side of equation (20). Under circumstances where there are no natural real exchange rate shocks, fixed exchange rates will be the superior regime if the domestic demand for money shows greater unanticipated variability than the demand for money in the rest of the world. When natural real exchange rate shocks are taking place, the variance of the unanticipated shocks to the domestic demand for money must exceed the variance of the unanticipated shocks to the rest-of-world demand for money by a sufficient amount to offset the variance of the natural real exchange rate if fixed exchange rates are to dominate flexible exchange rates with constant money growth. Could this plausibly occur?

The Pooling Hypothesis

Think of the world as consisting of n equal sized areas each with a variable S_t^i subject to random shocks. The value of the variable for the whole world will equal $S_t = \sum_i S_t^i$ and the stochastic deviation of it, taken in proportion to its expected value, will equal

$$DS_t = \frac{(S_t - E\{S_t\})}{E\{S_t\}} = \sum_i \frac{1}{n} \left[\frac{S_t^i - E\{S_t^i\}}{E\{S_t^i\}} \right].$$

When the shocks in the different areas are independent and have the same variance, the variance of the world shock will equal

$$Var(DS_t) = \sum_i \frac{1}{n^2} Var(DS_t^i) = \frac{1}{n} Var(DS_t^i). \quad (26)$$

The variance of the shock in any individual area will thus be n times the variance of the shock in the world as a whole. This makes it plausible that, unless natural real exchange rate variability is very great relative to variability of the rest-of-world quantity of money demanded, the variance of unanticipated shocks to the price level and, hence, the unemployment rate will be smaller under fixed exchange rates than under flexible rates with constant money growth. It must be noted here that under world-wide fixed exchange rates there must be some world monetary authority that creates a reserve currency or, alternatively, a large key-currency country to which all other countries peg their currencies. The key-currency country or world monetary authority must be following a policy of constant money growth under fixed as well as flexible exchange rates.

The main advantage of fixing the exchange rate is that it enables shocks to the domestic demand for money to be absorbed through international portfolio adjustments and endogenous money supply changes rather than being transmitted to the exchange rate and the domestic price level. The unanticipated shocks to the domestic price level will then be linked directly to the price-level shocks abroad, determined by the rest-of-world demand for money shocks. These shocks, being the pooled shocks of many countries like the domestic one, will be proportionally smaller than the domestic shocks. This can be described as the *pooling* property of fixed exchange rates—demand for money shocks are pooled across a large group of countries and, to the extent that the individual countries' shocks are uncorrelated with each other, a diversification effect occurs. Under flexible exchange rates with constant money growth this pooling is lost. At the same time, however, flexible exchange rates have an important *insulation* property—they insulate the domestic economy from shocks to the natural real exchange rate. Under fixed exchange rates this insulation is lost. So the critical issue is whether the

insulation advantage of flexible exchange rates with constant money growth outweighs the pooling advantage of fixed exchange rates.

A further issue, of course, is the degree of high-frequency monetary stability generated by the key-currency country or the world monetary authority under a fixed exchange rate system. Unavoidable deviations from constant money growth in the rest of the world could be greater than the deviations from constant domestic money growth if there is political instability in the key country or inappropriate political pressures on the world monetary authority. This could tip the scales in the direction of flexible exchange rates with constant money growth—the domestic authorities, unless subject to even greater domestic political problems, may be forced to “go it alone”.

Low-Frequency Price Level Movements

The above comparison of the two regimes deals strictly with the variance of the *unanticipated* price-level shocks—these are generated by deviations of the exogenous variables determining the quantities of money demanded from their expected levels. Of equal importance are the permanent movements in the expected price levels.

When the exchange rate is fixed, the expected price level is determined from (17):

$$E_{t-1}P_t = E_{t-1}P_t^* + E_{t-1}\vartheta_t - \sigma [\psi(Y_{t-1} - \theta_{t-1}) - \psi^*(Y_{t-1}^* - \theta_{t-1}^*)] \quad (27)$$

The expected price level will move through time along a path that will depend on the corresponding movements in the natural real exchange rate and the price level abroad. The trend rate of price growth in the rest of the world, and any shifts in it, will be directly passed through to the domestic price level. Random-walk movements of the natural real exchange rate will also be transmitted to the domestic price level, on top of any price trends in the rest of the world.

Under flexible exchange rates with constant money growth the expected domestic price level is given by equation (15), after substitution of (18). If the growth of the domestic and foreign natural levels of output proceed along stable trends, the domestic authority can create a stable domestic price level trend by choosing the proper trend rate of nominal money growth. Nominal exchange rate movements will insulate the domestic economy both from movements in the natural real exchange rate and from trend movements in the rest-of-world price level.

Major low-frequency movements of the domestic price level are not inconsequential. Quite apart from variations in the level of employment that result from the fact that, period by period, the price level movements are unanticipated, there are the cumulative movements in the price level that occur as the period-to-period changes add up. Such low-frequency price level

movements are costly because they create on-going redistributions of wealth between debtors and creditors and require constant adjustments of the institutions governing the process of private and social contracting. To the extent that price level trends are anticipated, these adjustments will be less costly. Trends resulting under fixed exchange rates from random-walk natural real exchange rate movements, however, cannot be forecasted.

Taking permanent price level movements into account introduces an additional factor determining the choice between fixed exchange rates and flexible exchange rates with constant money growth. Even if the unanticipated shocks to the domestic quantity of money are large enough to make the pooling advantage of fixed exchange rates greater than the *high-frequency* insulation advantage of flexible exchange rates with constant money growth, there also the *low-frequency* insulation advantages of flexible exchange rates to take into account. If the natural real exchange rate wanders far and wide, so will the price level under fixed exchange rates. There is some degree of natural real exchange rate variability that will offset any pooling advantage of fixed exchange rates and make flexible rates with constant money growth the preferable system.

Getting the Best of Both Worlds

Both the pooling advantages of fixed exchange rates and the low- and high-frequency insulation advantages of flexible exchange rates can be obtained simultaneously if the central bank has within-period information about the tightness of domestic monetary conditions relative to monetary conditions abroad. When the exchange rate is flexible, any difference between the right-hand sides of equations (19) and (20) will appear as portfolio pressure on the exchange rate that will ultimately be transmitted into unanticipated changes in the domestic price level relative to the price level abroad. Domestic residents' desired portfolio mix of monetary and non-monetary assets will differ from their actual mix at the existing structure of domestic and foreign interest rates and as a result they will attempt to buy or sell assets from foreign residents. Easier credit conditions in the rest of the world, for example, will lower world interest rates and with them domestic rates. In the absence of equivalently easier domestic credit conditions, domestic residents will find their existing money holdings too small. Easier domestic credit conditions, given credit conditions abroad, will have the opposite effect. Reestablishment of asset equilibrium in the face of differential domestic and foreign credit conditions creates an excess demand or supply of foreign exchange which will be transmitted to the nominal exchange rate, the domestic price level and the level of employment.

If the authorities, observing market conditions within-period, can determine whether domestic monetary conditions are tighter or easier than those abroad, they can adjust the domes-

tic nominal money stock to equalize credit conditions and eliminate portfolio pressures on the exchange rate. Perfectly done, this would mean that $DP_t = DP_t^*$ and the pooling advantages of fixed exchange rates would be maintained. Adjustments of the nominal exchange rate will offset the effects of $D\vartheta_t$ in equation (23) and also eliminate the domestic price level effects of all the cumulative movements in both the natural real exchange rate and the rest-of-world price level.

Note that the central bank can have within-period information about the tightness of domestic relative to foreign monetary conditions and the existence of portfolio pressures on the exchange rate without knowing the magnitudes of the structural parameters in the economy. Private agents can also have this information but it is of no use to them because they, too, lack quantitative information about the structural parameters. Only the authorities can use information about credit conditions because it is they who create money—if portfolio pressure on the exchange rate is evident, they can eliminate it. I refer to such monetary policy as *acquiescent* or *stochastically dependent*.⁸ The authorities try to prevent unnecessary exchange rate variability or, in central banking parlance, to maintain *orderly markets*.

Observed nominal exchange rate movements reflect portfolio adjustment pressures together with natural real exchange rate variations. To the extent that the authorities have some ability to attribute certain nominal exchange rate movements to portfolio pressures, they can use this information in conducting their orderly-markets smoothing policy. At the extreme, where no other information is available, the authorities could offset all current movements of the exchange rate by money supply adjustment and then allow nominal exchange rates to adjust next period to compensate for movements in the real exchange rate that become apparent when this period’s domestic relative to foreign price level movements are observed. In effect, the authorities would peg the nominal exchange rate at its *expected* level in each period and then adjust that expected level from period to period based on observed past movements in the price level and, hence, real exchange rate. Such a policy, which fits the characterization “leaning against the wind”, is worth undertaking if the pooling advantages of fixed exchange rates exceed the *high-frequency* insulation advantages of flexible exchange rates.

Smoothing errors are inevitable. If the shocks to the natural real exchange rate are small—and hence both the unanticipated and on-going price level movements that result from them are small—a fixed exchange rate will be best policy when there are significant pooling advantages and prices in the rest of the world are following a suitable trend. In this case, the

⁸ A single country’s monetary policy is *stochastically dependent*; the monetary policies of all countries are *stochastically interdependent*.

real exchange rate and the domestic price level would wander sufficiently slowly through time that the institutional contracting costs would be less than the unanticipated domestic price level variability that would result from letting the exchange rate float and trying with only limited success to offset the portfolio pressures resulting from domestic demand for money shocks. Flexible exchange rates with constant money growth can never be the regime of choice when the authorities have usable information about domestic vs. foreign credit conditions and the existence of portfolio pressures on the exchange rate.

Explaining the Facts

The commonality of the business cycle across countries under flexible exchange rates follows directly from orderly markets monetary policies. A reduction in the quantity of money demanded in a major country or group of countries, for example, will cause their credit conditions to be easy relative to the rest of the world, leading to downward portfolio pressure on their currencies prompting them to contract money growth. At the same time, other countries will experience upward portfolio pressure on their currencies prompting them to expand credit. The overall effect will be expansionary as long as some countries expand credit and the countries experiencing demand for money declines therefore contract by less than the full amount of those declines. Prices and employment will rise everywhere. An increase in the quantity of money demanded in a major part of the world will have the opposite effect. These world-wide monetary pressures can arise from institutional changes affecting the perceived cost of holding money, from changes in the public's desired ratio of cash to deposits or the banking systems' desired ratio of reserves to deposits, from changes in expectations about the future profitability of investment or future inflation, or from technological or other forces leading to changes in output growth. They can result from trend shifts as well as major stochastic shocks. Monetary pressures can also result from money supply shocks in a major country perpetrated by authorities who are unconcerned about effects on the external value of their currency—orderly markets policies on the part of the remaining countries will then lead them to adjust their money supplies in the same direction to offset the resulting upward portfolio pressures on their currencies. World-wide cyclical fluctuations in output and employment can also result from real business cycles that will be international in scope on account of the interconnections of the real sectors of the various economies. The timing and depth of cyclical movements, whatever their cause, will be different across countries for the same reason that different regions of the same country will be affected in different ways.

Interdependence of output and employment movements across countries also leads to interdependence of inflation rates as agents learn that aggregate demand has changed and prices

adjust similarly in all countries. Such changes in inflation rates will tend to be permanent if agents capitalize price level movements into their inflation expectations. To smooth the exchange rate in the face of stochastic shocks to the quantity of money demanded, the authorities have to constantly adjust the money supply to the quantity demanded by private agents. Agents' demands will depend in part on what they think the future inflation rate is going to be. Any difference between the actual and desired stocks of money will immediately result in pressure on the exchange rate. An orderly markets policy on the part of the central bank thus requires that all changes in private desired money holdings be financed. If the industrial and institutional structure is such that wages and other costs tend to rise a lot as the world economy expands then domestic prices will tend to rise relative to prices abroad and domestic residents' nominal quantity of money demanded will expand a lot. By the same token, agents in countries whose costs and prices tend to rise less as the world economy expands will desire smaller increases in nominal money holdings and the authorities will not have to expand the money supply as much.

It is also the responsibility of the central bank to keep the inflation rate from deviating substantially from the political consensus rate. This is inconsistent with keeping domestic capital markets in an "orderly condition" to minimize short-term price level and employment variations. The actual and expected inflation rate cannot be driven back to the consensus level without creating financial market disorder. Unless the bank is prepared to exercise some control over the trend rate of money growth, on the other hand, the inflation rate will have no effective limit. So what is the mechanism by which inflation rates will be kept within some sort of bounds?

The horizontal axis in Figure 3 (see page 32) gives the deviation of the inflation rate from the consensus or "core" rate and the vertical axis measures costs. The central bank is viewed as acting on behalf of the collectivity of private agents who control it through the political process. The curve BB gives the costs to the society of inflation in excess of the core rate—these are the "shoeleather" costs of making transactions with reduced money holdings, the distortions that arise because of the difficulties of cost and tax accounting in an inflationary environment, the menu costs of continually adjusting prices, and so forth. They also include those costs of inflation rate uncertainty that vary with the inflation rate. These inflation costs are assumed to increase with the deviation of the current inflation rate from the core rate.

The curve AA and the line CC give the costs of reducing the inflation rate to the core rate. AA represents the costs to private agents, borne individually, of calculating the core inflation rate and adjusting their price-setting and contractual activities to this new inflation rate. These costs can reasonably be viewed as an increasing function of the adjustment required—

the bigger the adjustment, the greater the costs of renegotiating old contracts or living with them until they expire. The line CC gives the collectively borne disorderly markets costs of having the central bank abandon monetary and exchange rate smoothing and adopt the constant money growth rate that will produce on average the core inflation rate. These costs are independent of the deviation of the inflation rate from the core rate because the central bank does not have enough within-period information to partially abandon orderly markets policy. Since it cannot determine how much disorder will be necessary to move the actual and expected inflation rate “a little bit” in the right direction, it either follows a smoothing policy or it targets on the rate of money growth and allows whatever financial market disorder this implies. The sum of the two types of adjustment costs is given by the curve TT. A switch from orderly markets policy to constant money growth will be appropriate for inflation rates at which BB is above TT. This will be the case when the deviation of the inflation rate from core goes outside the bounds GQ.

The financial market disorder costs can be eliminated if agents can collectively develop institutional arrangements to coordinate their activities. If they could all agree to conduct their price-setting and contractual activities as though the inflation rate were the core rate, while having the central bank commit to an orderly markets policy, they could reduce inflation to the core rate without incurring the disorderly markets costs given by the line CC. The optimal interval outside of which the inflation rate should be driven to core would then be **gq**. One way to do this might be to have the central bank commit to a rate of money growth that will produce the core inflation rate unless the actual inflation rate has fallen to the core rate by a given date. Time-consistency problems may result if it is in agents’ interest to have their central bank abandon commitments to maintain constant money growth before the actual inflation rate has fallen all the way to the core rate. The analysis of institutional arrangements of this sort involves game-theoretic issues that are beyond the scope of this present paper.

Despite coordination and time-consistency problems, it is probably reasonable to conclude that there will be some deviation of the current inflation rate from the core rate for which orderly markets policy will be at least temporarily abandoned. Since every country will have a core inflation rate based on some underlying consensus, and these core inflation rates will differ from country to country, observed inflation trends will also differ across countries. Inflation rates in all countries and the average world inflation rate will wander together at random, within bounds, around drifts determined by the underlying core inflation rates.

Unacceptable deviations of a single country’s inflation rate from core can be dealt with by fixing the exchange rate to the currency of a country whose inflation rate will produce a

domestic inflation rate more acceptable than the current one.⁹ This solves the financial market disorder problem because the fixed exchange rate regime imposes coordination on private agents and orderly markets policy on the central bank. Once the domestic inflation rate has fallen to an “acceptable” level the country can return to flexible exchange rates and orderly markets monetary policy. This approach is not feasible when the whole world has an inflation problem. A remedy in that case would be an international agreement to make one major currency, say the U.S. dollar, a key currency. The U.S. authorities would then operate their monetary policy without regard to its exchange rate implications and adopt either constant money growth or some form of orderly *domestic* financial markets policy at an acceptably lower rate of money growth. Other countries would then conduct orderly market policies as usual, perhaps forcing themselves to do so by pegging their currency to the dollar. The result would be a reduction of the U.S. inflation rate with inflation rates in the peripheral countries following along. Shocks to individual countries’ demand for money would be accommodated by adjustments of credit conditions in those countries. Shocks to the U.S. quantity of money demanded that reflect portfolio shifts between money and non-monetary assets or currency substitution toward or away from U.S. dollars in favor of foreign currencies in the aggregate would be reflected in U.S. aggregate demand and prices and would be passed through to the peripheral countries as a consequence of their exchange rate smoothing policies. Since the key currency country is a relatively small fraction of the world, the area over which money shocks are pooled would be smaller than under world-wide orderly markets policy. The system would thus be less stable than a world-wide regime in which the U.S. also conducts an orderly markets monetary policy. This is the price that must be paid to reduce the world inflation rate.¹⁰

The determination of forward and spot exchange rates and international interest rate differentials now has a straight-forward explanation. To the extent that the authorities in every country conduct an orderly markets monetary policy, real exchange rates will be determined by real forces such as consumption smoothing, oil prices, international shifts in investment

⁹ The potential effects on the price level of natural real exchange rate movements will become increasingly tolerable as the domestic inflation situation worsens.

¹⁰ The Bretton-Woods system established after World War II can be viewed in this context as a reaction to the uncoordinated world-wide disintermediation of the 1930’s [Eichengreen (1990)]. The signatories created a U.S. dollar centered key-currency system somewhat by accident—their intention was to set up a common currency system centered on gold that would have created a much larger pooling area for shocks to the individual countries’ quantities of money demanded.

opportunities, and so forth, plus a random error resulting from the inability of the authorities to perfectly smooth out international portfolio shocks. These real forces together appear to us over short periods as a random walk. Over very long periods they appear as low frequency processes that mean revert because forces affecting the relative price of a country's output in one direction eventually tend to be offset by forces affecting that relative price in the opposite direction. This near-random walk character of real exchange rate movements explains why today's real exchange rate is known to be the best forecast of tomorrow's real exchange rate [Meese and Rogoff, (1983)]. Movements in nominal exchange rates will equal the movements in the corresponding real exchange rates adjusted for the difference in the inflation rates of the two currencies. While countries' inflation rates will tend to move together, these movements are typically not equal in magnitude. Accordingly, the actual and expected inflation rates of countries whose core inflation rates are very similar (e.g., Canada and the United States) will frequently differ by a percentage point or two. Since these differences in inflation rates between countries will tend to be quite stable over short time-horizons, a reasonable naive forecast will be a projection based largely on previous periods' realizations. Accordingly we would expect the forward discount on any currency in terms of another and the interest rate differential on securities denominated in those two currencies to equal this projected inflation rate differential. Since inflation differentials change very little as compared to real exchange rates, we would expect the forward discount to predict a very small fraction of observed nominal exchange rate movements. This is consistent with the evidence [Mussa, (1979)].

Regime Choice: Positive and Normative Issues

There has been a long-running debate in the profession about the merits of flexible exchange rates vs. fixed rates. The results here dispel any notion that a blanket case can be made for either regime over the other—the choice must be circumstance specific. Nevertheless, when real exchange rates are wandering as widely as they have been since the breakdown of the Bretton-Woods system, flexible rates are almost certainly the best regime. The case is stronger if central banks have within-period information about domestic relative to foreign monetary conditions that will enable them to offset portfolio pressures on the exchange rate and thereby pool domestic monetary shocks with those in the larger outside world. Even when direct information about credit conditions is poor, the authorities can expect to obtain some pooling by leaning temporarily against nominal exchange rate movements, allowing exchange rates to adjust only when hindsight makes it clear that natural real exchange rate changes are the driving force behind them.

One can imagine circumstances where the unanticipated period-to-period natural real ex-

change rate shocks are so great that stabilizing the nominal exchange rate will result in greater unanticipated shocks to the domestic price level than would result from allowing domestic demand for money shocks to have their full impact—that is, where the high-frequency insulation properties of flexible exchange rates exceed the pooling advantage of fixed rates. When, in addition, the only information about credit conditions the authorities have is contained in observed nominal exchange rate movements, smoothing becomes deleterious and flexible exchange rates with constant money growth will be the best regime. It must be noted, however, that no country has ever adopted constant money growth with flexible exchange rates for any extended period, central bank rhetoric of the late 1970s notwithstanding.¹¹ This suggests that the authorities have never perceived that they could reduce unanticipated price level shocks more by stabilizing the rate of money growth than by stabilizing financial markets. It would be surprising if these perceptions were consistently and uniformly wrong at all times and places. If the authorities have information about domestic vs. foreign credit conditions independent of observed exchange rate movements, an orderly markets policy will always dominate constant money growth.

When natural real exchange rate movements are small, with the result that real exchange rates exhibit very shallow trends, where foreign inflation rates are acceptable, and where central banks have insufficient information to completely smooth out portfolio shocks to the exchange rate, there is a case for fixed exchange rates. The latter regime makes the pooling of domestic and rest-of-world demand for money shocks automatic at the cost of losing the insulation properties of flexible exchange rates. Indeed, central banks and bureaucrats have shown a distinct preference for fixed exchange rates under these circumstances. Flexible exchange rates tend to be the lesser of evils—when real exchange rates are wandering far and wide the unanticipated price level variability that results from the inability of the authorities to eliminate all portfolio shocks to the exchange rate becomes tolerable in comparison to the major low-frequency price level movements that would otherwise occur if the nominal exchange rate were fixed.

Normative questions aside, the analysis here also presents a positive theory of regime choice—it enables delineation of the conditions under which countries will choose a particular regime. It predicts that countries will tend to adopt fixed exchange rate regimes when natural real exchange rates show little low-frequency variability and flexible exchange rate regimes when substantial low-frequency natural real exchange rate variability is occurring. It also predicts that both high- and low-frequency real exchange rate movements will be greater

¹¹ For evidence on this point relating to the U.S. see Friedman (1988).

under flexible exchange rates than under fixed rates. High frequency variations will be greater because the authorities will make smoothing errors under flexible exchange rates whereas total stochastic interdependence is automatically imposed by fixed exchange rates. The available evidence corroborates this, as the proponents of fixed exchange rates have long argued. Low-frequency variations of real exchange rates will be greater under flexible rates than fixed rates because countries will abandon fixed rates for flexible rates when major real exchange rate movements are taking place, and gravitate back to fixed exchange rates when real exchange rates exhibit stable and shallow trends.

Evidence confirming this was presented in an earlier study [Floyd (1985)]. Figure 4 (see page 33) plots the real exchange rates for Germany, France, Italy, United States, United Kingdom and Canada during the gold-standard period 1880–1913, the inter-war period 1924–38, the Bretton-Woods period 1950–71 and the managed-floating period 1973–1990. During the gold standard and Bretton-Woods periods exchange rates were fixed (except for Canada in the latter period) and during the other two periods the fixed exchange rate system broke down. For every country but Canada, low-frequency real exchange rate variability was much greater during the flexible exchange rate periods than when exchange rates were fixed. Canada’s real exchange rate varied as much in the Bretton-Woods period as it did in the flexible rate periods and, as the theory predicts, that country broke ranks and maintained a flexible exchange rate during much of the Bretton-Woods period. Canada also had substantial low-frequency real exchange rate variability during the years of prairie settlement before the first world war but the average annual change between 1897 and 1908 was still only about 3 percent. The U.S. real exchange rate had a downward trend and the real exchange rates of Italy, Germany and the U.K. upward trends for the entire period after the second world war but again the trend rates of change were less than 3 percent per year and the deviations around trend were far greater after 1973 than before.

A skeptic would argue that greater variability of real exchange rates in flexible exchange rate periods is the result of erratic monetary forces rather than natural real exchange rate movements, citing monetary instability as the reason for abandoning fixed rates. But this criticism implausibly assumes an absence of price level adjustments for long periods over which low-frequency real exchange rate adjustments were occurring.¹² To argue that this greater

¹² It might also be argued that the major reason for adopting the gold standard was to keep monetary policy out of the control of the government, so that the fixed exchange rate regimes in this period had nothing to do with pooling demand for money shocks. Further analysis of the real exchange rate movements of countries that were slow to adopt the gold standard in preference to fiduciary money—for example, Austria-Hungary, Russia and Argentina—might

variability was due to erratic monetary policy, one would have to postulate persistent rigidity of countries' *relative* price levels during a time when world inflation rates were changing substantially. To illustrate, consider the infamous real and nominal appreciation of the U.S. dollar during the period 1980–84. Over a four year period, the currency appreciated by more than 50 percent. Without sticky prices, a 50 percent appreciation of the U.S. real exchange rate not based on exogenous real factors would have resulted in some combination of a 50 percent fall in the price level in the U.S. and a 50 percent rise in the price level in the rest of the world. Yet all countries shown in Table 1 experienced substantial reductions in their inflation rates between 1980 and 1984. For a price stickiness argument to be convincing, U.S. prices would have had to be sticky downward and foreign prices sticky upward, but the fall in the foreign inflation rates implies downward rather than upward pressure on foreign prices.

Table 2: Inflation Rates of Selected Countries
Percent Per Year, 1980 and 1984

	1980	1984	Difference
U.S.	9	2	7
U.K.	15	3	12
Germany	6	0	6
France	12	3	9
Italy	17	5	12
Sweden	14	4	10

Sources: *Cansim* for Canada, *Citibase* for the U.S. and IMF, *International Financial Statistics* and OECD, *Main Economic Indicators* for the remaining countries.

Although countries clearly pursue orderly markets monetary policies rather than constant money growth when exchange rates are flexible, it is impossible within the scope of this paper to determine their degree of success at smoothing out portfolio shocks to the exchange rate. That smoothing occurs is consistent with the close correspondence of real and nominal exchange rates in Figure 1 (see page 30) and the absence of any apparent relationships between exchange rates and the ratio of domestic to foreign price levels. Also, once allowance has been made for the effects of real shocks there is no evidence of any statistical relationship between unanticipated money shocks and shocks to the real exchange rates for the nine countries in

prove fruitful.

Figure 1 for a variety of definitions of unanticipated money [See Floyd (1995)]. This is as the theory predicts—observed unanticipated shocks to the money supply will reflect shocks to the demand for money financed by the monetary authorities in order to eliminate their effects on the exchange rate.

The analysis here suggests that a laissez-faire international monetary regime in which countries either pursue orderly-markets monetary policies with flexible exchange rates or fix their currencies to currency areas having stable inflation rates with which they also have stable natural real exchange rates will function well in the absence of major world-wide stochastic shocks or trend-shifts in output or the demand functions for money. World-wide price level and employment fluctuations will occur, either as a result of minor stochastic shocks or trend shifts or from international real business cycles. Individual small countries that get into inflation difficulties because of political pressures to print money can extricate themselves by free-riding off the stability elsewhere. Fixing their currencies to the currency of a major stable country or group of countries is a way of demonstrating a commitment to monetary stability. No explicit international cooperation is necessary under these circumstances.

Serious problems will arise, however, when a major country or group of countries gets into trouble. The trouble will spread to the remaining countries if they follow orderly markets policies. An example is the world-wide financial disintermediation that occurred in the 1930s. Here, explicit international cooperation will be necessary to minimize the damage. The otherwise stable countries can agree to ignore the exchange rates of the unstable ones and conduct orderly market policies with respect to each other. Or a major stable country can assume a key-currency role with other countries either minimizing the portfolio shocks to their exchange rates with respect to that key currency or pegging to it. The entire world will ultimately return to stability if stability can be achieved in one major country or group of countries—the Bretton-Woods system was an example of this kind.

Finally, the above analysis seemingly rejects the grand design of constant money growth along lines proposed by Friedman (1962), Meltzer (1987) and others, suggesting that it is not from stupidity that countries have never been persuaded to maintain constant money growth. The rejection stems from consideration of the pooling advantages of aggregating demand for money shocks across countries. There are important gains from maintaining harmony between monetary conditions in all countries that cannot be achieved if everyone follows constant money growth. Nothing in the present analysis, however, is inconsistent with the view that a world monetary authority, if one existed, or a major key currency country to which many other countries peg, should follow constant money growth. The traditional advocates of money growth rules reasoned essentially from a closed-economy perspective. That perspective may

still be relevant for a country charged with proceeding independently of other countries to provide an anchor for the world currency system.

Data Sources

The data for Figures 1 and 2 and Table 1 are from the sources indicated in the relevant footnotes. The price series used are the CPI's. The series in Figure 4 for the period 1957–1990 for all countries except France before 1982 and Canada were obtained from *International Monetary Fund: International Financial Statistics*. Implicit GDP deflators (GNP in the case of Germany) were used as the price series for all countries and time periods. For the U.S. the source was Romer (1989) for 1880–1929 and Friedman and Schwartz (1963) for 1930–1956. The U.K. series are from Deane (1968) for the period 1880–1914, Friedman and Schwartz (1963) for 1915–1956. The German Data for the period before 1957 are from Mitchell (1975). For Italy the pre-1957 data are from compilations by Michael D. Bordo using Mitchell (1975) and other sources. The French data for the period 1880–1982 are from Toutain (1987). The Canadian data are from Green and Urquhart (1987) for the period 1880–1926 and from *CANSIM* thereafter. All of these data, except for those from the IMF, were brought together in the form used here by Trevor J. O. Dick.

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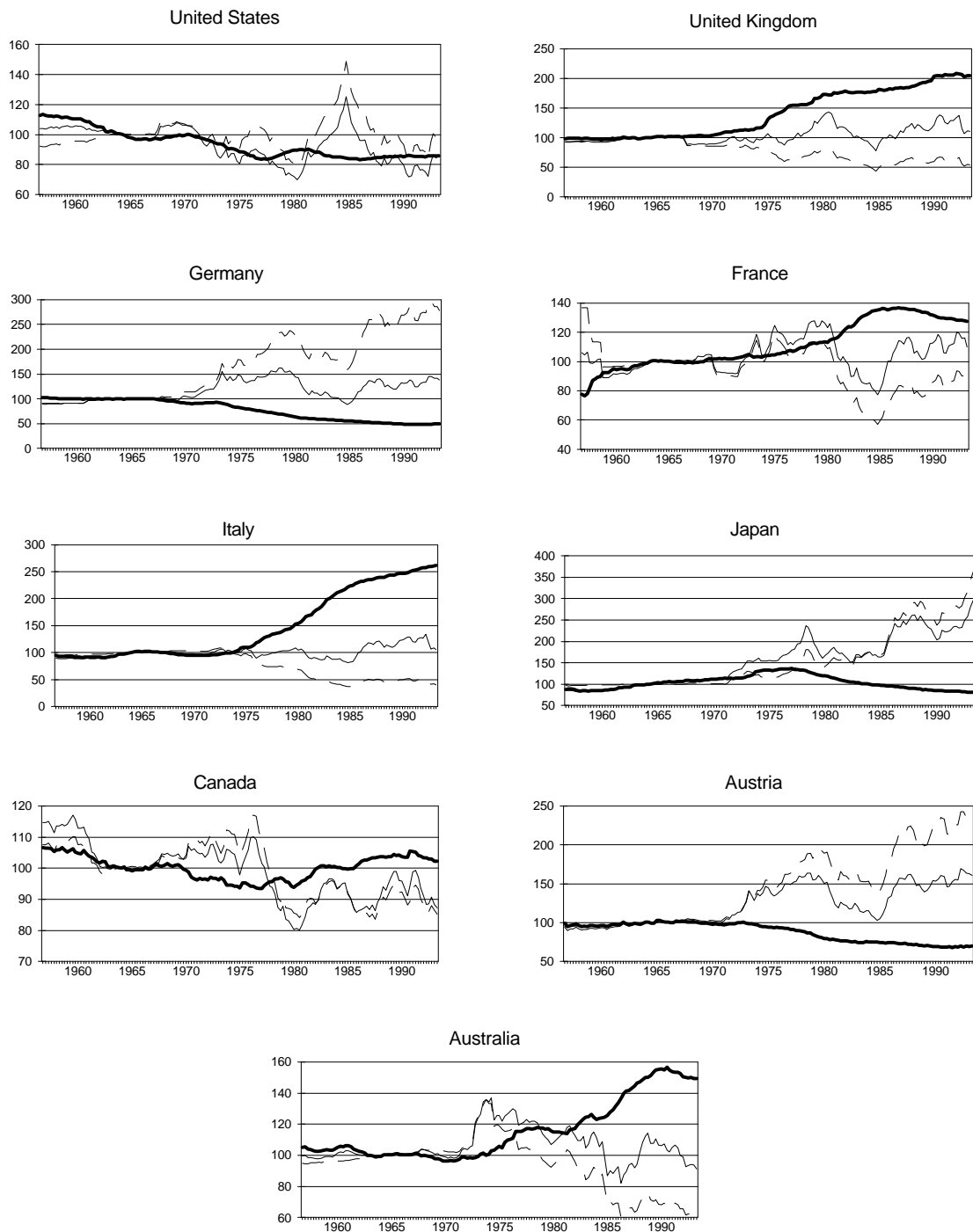


Figure 1: Real exchange rate (*thin solid line*), nominal exchange rate (*broken line*) and ratio of the domestic to rest-of-world price levels (*thick solid line*) for selected countries, 1957–1993, 1980 = 100. Source: *International Financial Statistics*.

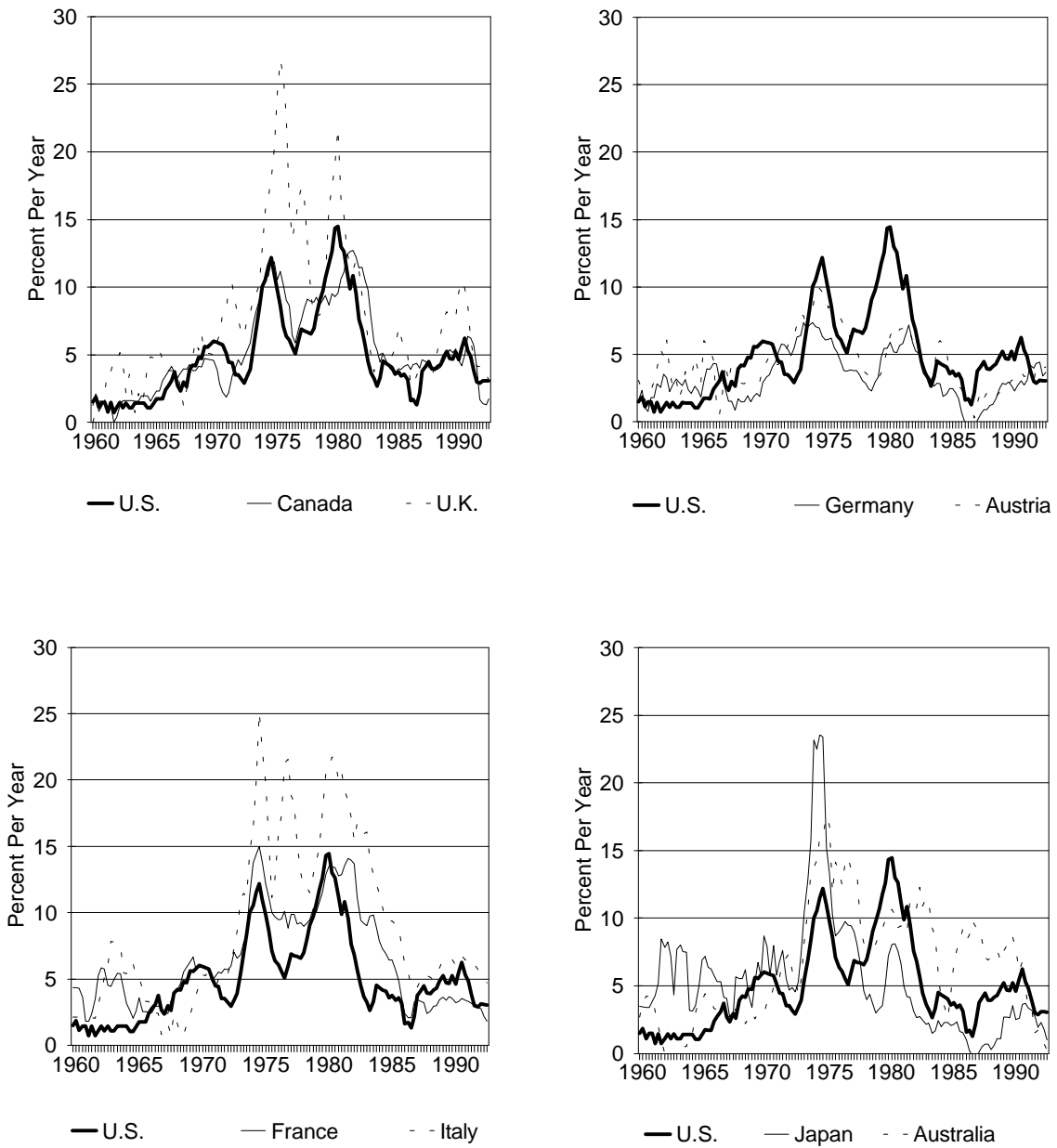


Figure 2: Inflation rates of selected countries as compared to the United States, 1960–1993, percent per year. Source: *International Financial Statistics*.

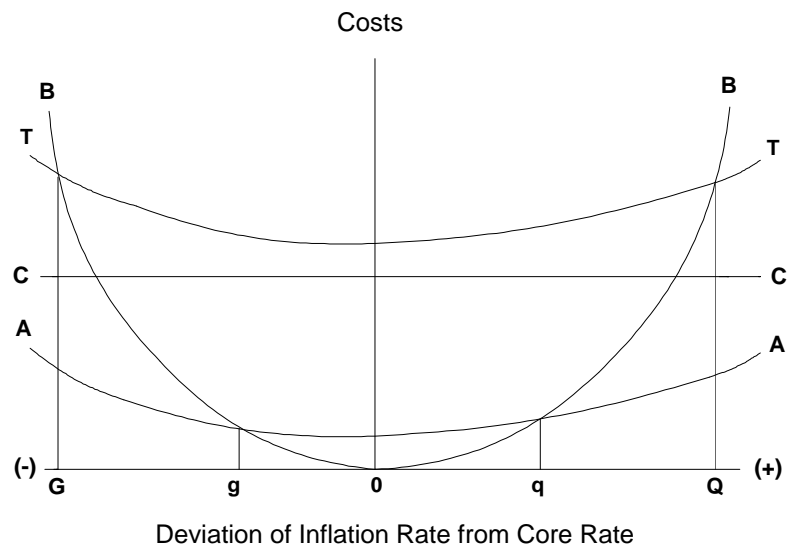


Figure 3: Costs of maintaining orderly markets versus the costs of setting a constant rate of money growth.

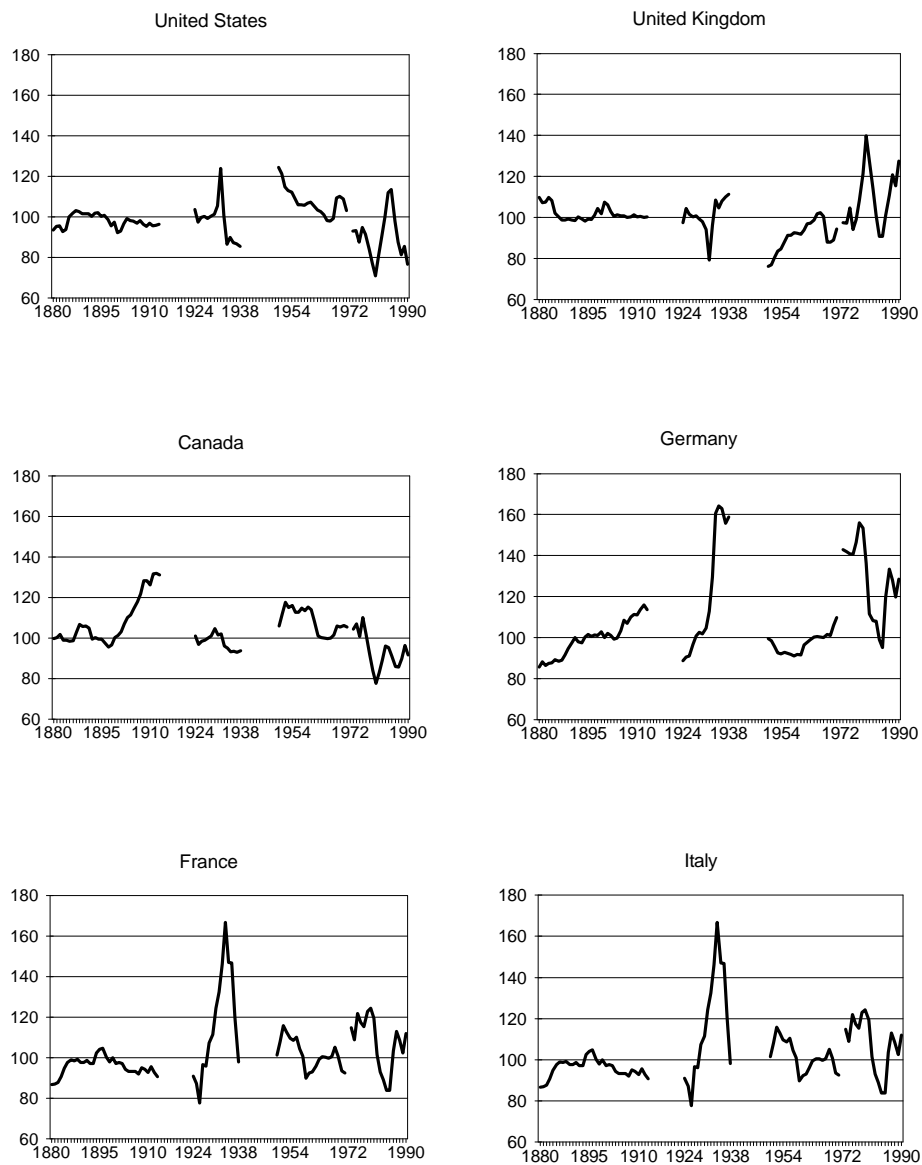


Figure 4: Real exchange rates of selected countries: 1880–1913 (1890–99 = 100), 1924–1938 (1927–29 = 100), and 1950–1971, 1973–1990 (1963–66 = 100). Source: See Data Sources.