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International Monetary Regimes and Incidence and Transmission of Macroeconomic Shocks: Evidence from the Bretton Woods and Modern Floating Periods

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This paper investigates the relationship between international monetary regimes and incidence and transmission of macroeconomic shocks within the context of an open-economy macro model. Empirical results confirm monetary interdependence and lower incidence of monetary discretion under fixed exchange rates. The average magnitude and dispersion of supply shocks in Bretton Woods and the subsequent float is comparable; however, the average magnitude and dispersion of real demand shocks under Bretton Woods seems higher. Overall, the international monetary regime may pose important constraints to policymakers in open economies.

1. Introduction

Economists have long recognized the role of a flexible exchange rate regime in insulating economies and allowing independent pursuit of monetary policy. However, experience with floating rates in the post–Bretton Woods period led many to question the merits of flexible rates with increased volatility in nominal and real exchange rates and the implied effects of this volatility on international trade flows.

Although fixed rates reduce uncertainty and transaction costs compared with flexible rates, these benefits may be outweighed by increased output volatility due to sticky prices and increased international interdependence. If countries face idiosyncratic shocks, independent monetary policy is needed to stabilize the domestic economy. Theoretical work on the effects of international monetary regimes has been inconclusive. Helpman (1981), Dornbusch (1983), Turnovsky (1983), and others provide evidence that exchange rate arrangements cannot be ranked unambiguously in terms of their impact on macroeconomic stability or domestic welfare. Instead, several studies have analyzed macroeconomic performance under different historical exchange rate arrangements. Using macroeconomic data from the Bretton Woods and the subsequent floating regime, Baxter and Stockman (1988) found no clear relationship between exchange rate flexibility and output stability or synchronization of the business cycle. Using bivariate vector autoregressions (VARs), Bayoumi and Eichengreen (1994) analyzed the standard

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deviations of supply and demand shocks under alternative monetary regimes and found little difference in the incidence of supply and demand shocks under the Bretton Woods and the subsequent float.

It is known that the effects of the international monetary regime depend on some structural characteristics (e.g., openness, capital mobility, and the existence of rigidities), as well as the types and sources of shocks impinging on the domestic economy. Because fixed rate systems set limits to discretionary policy, one may expect a lower incidence of domestic demand shocks under fixed rate systems. Similarly, a fixed rate system can be viewed as a commitment mechanism that prevents the policymaker from pursuing expansionary policies. Thus, an interesting question is to disentangle the effects of policy shocks, which may be attributable to the monetary regime, from those of the macroeconomic environment and examine whether the switch to flexible rates was prompted by an unusual incidence of certain types of shocks.

The objective of this paper is to reexamine the relationship between international monetary regimes and the incidence and coherence of macroeconomic shocks using a disaggregated framework. To that end, I present a simple macroeconomic model and try to identify a set of shocks using a combination of short-run and long-run restrictions. Using quarterly data from the G7 countries pertaining to Bretton Woods and Modern Floating periods, I distinguish between supply shocks, money supply shocks, real demand shocks, money demand shocks, and capital flows shocks. Examining the incidence and coherence of the shocks can shed some light on the effects of the exchange rate regime and conduct of macroeconomic policy under alternative exchange rate systems. It is also possible to examine the role of country-specific shocks in the collapse of the Bretton Woods system. Section 2 presents the theoretical framework and methodology. The model is illustrative in that it has a simple formulation while providing a reference for identifying a set of orthogonal shocks. Section 3 presents empirical results, and section 4 concludes.

2. Theoretical Framework and Methodology

My starting point in identifying a set of orthogonal impulses is the familiar Aggregate Supply (AS)–Aggregate Demand (AD) framework, which is widely used in explaining macroeconomic fluctuations. Consider an AS–AD model with a Lucas-type supply function, and a wedge between consumer and producer prices:

$$y_t^d = \alpha_0 - \alpha_1[i_t - (E_{t-1}p_{t-1}^c - E_{t-1}p_t^c)] + \alpha_2(p_t^* + s_t - p_t) + \epsilon_{ist} \tag{1}$$

$$y_t^s = \beta_1(p_t - E_{t-1}p_t) - \beta_2(p_t^* + s_t - p_t) + \rho_t \tag{2}$$

$$p_t^c = \gamma p_t + (1 - \gamma)(p_t^* + s_t), \qquad 0 < \gamma < 1 \tag{3}$$

$$m_t - p_t^c = ky_t - \lambda i_t + \epsilon_{mdt} \tag{4}$$

$$E_{t-1}s_{t+1} - s_t = i_t - i_t^* + \epsilon_{cft}, \tag{5}$$

where y is real output, i is the nominal interest rate, s is the exchange rate expressed as the domestic currency price of foreign currency, p is the domestic price level, p^c is consumer prices, m is the money stock, ρ is the exogenously given capacity output, asterisks denote foreign counterparts of domestic variables, ϵ_t are orthogonal stochastic disturbances, and all variables except interest rates are in logarithms. It is further assumed that E_{t-1}, the conditional expectation, is calculated using the model and all relevant information as of the end of period $t-1$.

Equation 1 is an aggregate demand equation where aggregate demand for domestic goods and services depends on the expected domestic real interest rate and the real exchange rate ($s + p^* - p$) defined as the relative price of foreign goods. Equation 2 is the aggregate supply schedule, which can be justified using a wage-price sector framework. An interesting feature of this specification of aggregate supply behavior is that changes in the real exchange rate may have nontrivial output effects. Exogenous improvements in the terms of trade affect the profitability of investment because import costs change relative to output costs, which may induce a supply-side response. Second, if labor supply is a function of the real wage defined relative to consumer prices (Eqn. 3), an exogenous decrease in the real exchange rate will reduce the wage pressure in the labor market. If domestic firms do not reduce their markup on costs to compensate for the wage pressure, equilibrium employment may be expected to increase. More importantly, the real exchange rate influences the import costs of raw materials and intermediate inputs, which implies that permanent changes in the real exchange rate may have significant supply-side effects. One may also expect increases in the real exchange rate to increase the domestic production of import substitutes.

Equation 3 is the consumer price index, which is a geometric weighted average of domestic and foreign prices. Equation 4 is a conventional money demand equation with a disturbance term, which can capture a stochastic shift in, say, velocity. Equation 5 is the uncovered interest parity condition with a stochastic disturbance term and can be rewritten as

$$E_{t-1}q_{t+1} - q_t = r_t - r_t^* + \epsilon_{cft}, \tag{5a}$$

where q is the real exchange rate and r is the *ex ante* real interest rate.

It is assumed that p_t^*, i_t^*, ρ_t, and m_t are exogenous processes. However, under a fixed exchange rate system, each country must accommodate fluctuations in money demand to keep the nominal interest rate compatible with foreign interest rates. In this case, the money stock is demand-determined (i.e., endogenous) and the nominal exchange rate, s_t, is exogenous. Moreover, it is assumed that the domestic country is small so that foreign variables are exogenously given. To facilitate the exposition, assume that $p_t^* = i_t^* = 0$. It is trivial to generalize the case to two large countries by assuming the behavioral parameters are equal across countries. In this case, domestic country variables can be reinterpreted as the difference between domestic and foreign variables.

Consider the steady-state equilibrium under flexible exchange rates which can be derived by setting all disturbances in Equations 1–5 to zero and assuming expectations are realized. Denoting the steady-state values by bars, the solution for the endogenous variables are

$$\bar{y} = \frac{\alpha_2\bar{\rho} + \beta_2\alpha_0}{\alpha_2 + \beta_2} \tag{6a}$$

$$\bar{q} = \frac{\bar{\rho} - \alpha_0}{\alpha_2 + \beta_2} \tag{6b}$$

$$\bar{s} = \bar{m} - k\bar{\rho} + \frac{(\gamma + k\beta_2)(\bar{\rho} - \alpha_0)}{\alpha_2 + \beta_2} \tag{6c}$$

$$\bar{p} = \bar{m} - k\bar{\rho} + \frac{(\gamma - 1 + k\beta_2)(\bar{\rho} - \alpha_0)}{\alpha_2 + \beta_2}. \tag{6d}$$

As stressed by Turnovsky (1983), these equilibrium values relate to the means of the long-run distributions of the random variables y_t, q_t, s_t, p_t, not conditional on any knowledge of disturbances.

Notice that the familiar neutrality properties are evident in Equations 6a–6d. Output and the real exchange rate are determined by the exogenous capacity output and are independent of the money supply process. Moreover, in the steady state, an increase in the money supply increases the price level and the nominal exchange rate by the same proportion.

Following conventional practices, I derive the short-run behavior of the system by expressing Equations 1–5 as deviations from expected values (the forward looking solution to the expected values of the price level and the nominal exchange rate are derived in the Appendix). Subtracting expected values of Equations 1–5 from the original equations and denoting deviations from expected values by hats, output, and real exchange rate deviations under a flexible exchange rate system can be expressed as

$$\hat{y}_t = 1/J\{[\alpha_2(1 + \lambda) + \alpha_1\gamma]\epsilon_{st} + [(1 - \gamma)\beta_1 + \lambda(\beta_1 + \beta_2) + \beta_2]\epsilon_{rst} + [\alpha_1(\beta_1 + \beta_2) + \beta_1\alpha_2]$$

$$- [\alpha_1(\beta_1 + \beta_2) + \beta_1\alpha_2]\epsilon_{mdt} + [\alpha_2\beta_1\lambda - \alpha_1(\beta_1(1 - \gamma) + \beta_2)]\epsilon_{cft}\} \tag{7a}$$

$$\hat{q} = 1/J\{(1 + \lambda + k\alpha_1)\epsilon_{st} - (1 + k\beta_1 + \lambda)\epsilon_{ist} + (\beta_1 - \alpha_1)\epsilon_{mst} + (\alpha_1 - \beta_1)\epsilon_{mdt}$$

$$+ [\alpha_1(1 + k\beta_1) + \beta_1\lambda]\epsilon_{cft}\} \tag{7b}$$

$$J = \beta_1(1 - \gamma + \lambda) + (\alpha_2 + \beta_2)(1 + \lambda) + \alpha_1\gamma + k_1\beta_1(\alpha_1 + \alpha_2) + \alpha_1(\gamma + k\beta_2) > 0,$$

where I utilize the fact that $\epsilon_{st} = \rho_t - E_{t-1}\rho_t$, $\epsilon_{mst} = m_t^s - E_{t-1}m_t^s$; so ϵ_{st} and ϵ_{mst} are stochastic shocks to capacity output and the money supply, respectively. Under a fixed exchange rate regime, the solution for output deviations can be derived in a similar fashion. Note from Equation 7a that the short-run effects of a supply shock, demand shock, and a money supply shock on output are positive, the effect of a money demand shock is negative, and the effect of a capital flows shock is ambiguous. The latter stems from the fact that a capital flows shock has negative output effects because of the increase in the real exchange rate, and it has a positive effect because it reduces domestic interest rates and stimulates domestic output.

Using different versions of the AS–AD model, Artis and Currie (1981), Turnovsky (1983), and others compare stability properties of alternative policy regimes in open economies under different environments, and the exercise will not be pursued in this paper. The important point is that as Equations 7a and 7b demonstrate, the variances of output and other endogenous variables under different exchange rate regimes depend on structural characteristics (represented by model parameters) as well as on the variances of the shocks $var(\epsilon_i)$. In the empirical model, I try to estimate the standard deviations of the shocks across exchange rate regimes to gain an insight on how the exchange rate system influences macroeconomic stability.

The structural shocks assumed to drive the observed movements in the variables in the model are real demand (IS) shocks (ϵ_{is}), money supply shocks (ϵ_{ms}), money demand shocks (ϵ_{md}), supply shocks (ϵ_s), and capital flows shocks (ϵ_{cf}). The distinction between money supply shocks and money demand shocks such as stochastic shifts in velocity is important because the former is directly linked to the exchange rate system while the latter has little to do with the exchange rate system. Moreover, given the debate surrounding speculative capital movements and exchange rate variability and proposals aimed at limiting this variability, a measure of exogenous movements in exchange rates is needed.[1] Following Artis and Currie (1981), I adopt the term *capital flows shocks* to represent stochastic deviations from uncovered interest parity.

Theoretical framework above implies that aggregate demand shocks in the broad sense (goods market and money market shocks) have short-run effects on output, and supply shocks have permanent effects. Moreover, a typical propagation mechanism for monetary shocks is to be transmitted to the real sector through their effect on real interest rates. My methodology is to try to use these properties to identify the shocks within a structural VAR framework. This approach has been commonly used in empirical work (Shapiro and Watson 1988; Blanchard and Quah 1989; Gali 1992). The latter study combines short-run restrictions with long-run restrictions to identify the shocks, and I follow the same strategy in this paper.

Data and Identification

To allow a sufficiently disaggregated framework where one can distinguish between policy shocks and those attributable to the macroeconomic environment, I try to identify a vector of structural shocks, $\epsilon = [\epsilon_s\ \epsilon_{ms}\ \epsilon_{is}\ \epsilon_{md}\ \epsilon_{cf}]$. To that end, I let the VAR consist of output (y), nominal interest rates (i), real interest rates (r), real money balances ($m - p$), and real exchange rates (q). I measure output by the real GDP index in 1990 prices, except for Germany where it is measured by the real GNP index; nominal interest rates by call money rate or equivalent, except for Italy and Canada where it is measured by the interbank rate; the money stock by M1; prices by the Consumer Price Index; and the exchange rate by the nominal effective exchange rate (NEER). The real exchange rate for any particular country is obtained by deflating NEER with the domestic price level and the average price level of the remaining G6 countries. Quarterly data from 1957.I to 1996.I are obtained from the International Financial Statistics, except for missing national accounts data, which have been obtained from OECD National Accounts.[2]

Proper specification of the VAR necessitates testing for time series properties of the data. As a preliminary step, I use the KPSS test to characterize low frequency properties of the data. The test takes stationarity as the null hypothesis against the alternative of a unit root. Table 1 reports test statistics for the Bretton Woods (1957.I–1973.I) and Modern Floating periods (1973.II–1996.I).

The table indicates that output can be characterized as a unit root process in both periods. Test statistics for the remaining variables are not as clear. Nominal interest rates seem to be nonstationary in the Bretton Woods period while the test statistic indicates stationarity except for the United States and Japan in the Modern Floating period. The test statistic for the *ex post* real interest rate seems to indicate stationarity, whereas in several cases the evidence is in favor of a unit root. Similarly, the statistic for real money balances indicates a unit root in all cases except for the United Kingdom in the Bretton Woods period, where $m - p$ is stationary. Growth of real money balances is mostly stationary except for Japan in the Modern Floating period,

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[1] Proposals for limiting capital mobility and exchange rate variability include a traditional interest equalization tax (Artis and Currie 1981), deposit requirements on capital inflows, and a "Tobin tax" on foreign exchange transactions. For a discussion of the latter proposals, see Frankel (1995).

[2] Quarterly national income data for the 1957–1959 period were unavailable for France, Germany, and Italy. I obtained simulated quarterly data using industrial production. Consistent M1 data for the United Kingdom were not available. I use an index of M1 from International Financial Statistics (IFS) for 1957–1992 and update it for 1993–1996 using *OECD Main Economic Indicators.*

Table 1. KPSS Tests for Stationarity[a]

	Bretton Woods Period					
	y	i	r	$m - p$	$\Delta m - \Delta p$	q
United States	0.790*	0.594*	0.550*	0.782*	0.064	0.451
Canada	0.791*	0.466*	0.303	0.755*	0.088	0.363*
Japan	0.789*	0.543*	0.681*	0.798*	0.132	0.623*
United Kingdom	0.798*	0.341	0.158	0.102	0.075	0.659*
France	0.787*	0.363*	0.346	0.714*	0.165	0.658*
Germany	0.773*	0.436*	0.331	0.795*	0.146	0.714*
Italy	0.785*	0.400*	0.105	0.743*	0.100	0.126
	Modern Floating Period					
	y	i	r	$m - p$	$\Delta m - \Delta p$	q
United States	1.111*	0.387*	0.261	0.845*	0.232	0.355*
Canada	1.110*	0.253	0.179	0.863*	0.246	0.944*
Japan	1.114*	0.654*	0.382*	1.066*	0.452*	1.090*
United Kingdom	1.088*	0.261	0.451*	0.970*	0.311	1.040*
France	1.103*	0.279	0.135	0.793*	0.093	0.775*
Germany	1.095*	0.055	0.061	1.052*	0.248	1.080*
Italy	1.103*	0.242	0.354*	0.891*	0.063	1.070*

	Model Specification	
	Bretton Woods	Modern Floating
United States	$X^{US} = [\Delta y\ \Delta i\ \Delta r\ \Delta m - \Delta p\ \Delta q]'$	$X^{US} = [\Delta y\ \Delta i\ r\ \Delta m - \Delta p\ \Delta q]'$
Canada	$X^{CA} = [\Delta y\ \Delta i\ r\ \Delta m - \Delta p\ \Delta q]'$	$X^{CA} = [\Delta y\ i\ r\ \Delta m - \Delta p\ \Delta q]'$
Japan	$X^{JA} = [\Delta y\ \Delta i\ \Delta r\ \Delta m - \Delta p\ \Delta q]'$	$X^{JA} = [\Delta y\ \Delta i\ \Delta r\ \Delta^2 m - \Delta^2 p\ \Delta q]'$
United Kingdom	$X^{UK} = [\Delta y\ i\ r\ m - p\ \Delta q]'$	$X^{UK} = [\Delta y\ i\ \Delta r\ \Delta m - \Delta p\ \Delta q]'$
France	$X^{FR} = [\Delta y\ \Delta i\ r\ \Delta m - \Delta p\ \Delta q]'$	$X^{FR} = [\Delta y\ i\ r\ \Delta m - \Delta p\ \Delta q]'$
Germany	$X^{GE} = [\Delta y\ \Delta i\ r\ \Delta m - \Delta p\ \Delta q]'$	$X^{GE} = [\Delta y\ i\ r\ \Delta m - \Delta p\ \Delta q]'$
Italy	$X^{IT} = [\Delta y\ \Delta i\ r\ \Delta m - \Delta p\ q]'$	$X^{IT} = [\Delta y\ i\ r\ \Delta m - \Delta p\ \Delta q]'$

[a] Lag truncation is set at eight.

* The rejection of the null hypothesis of stationarity at the 10% significance level.

where it seems nonstationary. Real exchange rates seem to be integrated in most cases while the test statistic indicates stationarity for Italy in the Bretton Woods period. To specify a benchmark model, I difference the data where the test statistic rejects stationarity at the 10% significance level, and the resulting specifications are given at the bottom of Table 1. I also report results from alternative specifications below.

The theoretical model above implies that output, real money balances, and the real exchange rate may share common stochastic trends in the long run. To properly specify the empirical model, I test for cointegration among these variables using Johansen's likelihood ratio test. The test indicated no significant cointegrating relationships except in few cases: the United States and France in the Bretton Woods period and Germany under the float. In these cases, estimated asymptotic standard errors associated with the long-run coefficients were high. In what follows, I assume that the data have no cointegrating relationships, and I estimate a VAR in levels and first differences.

Consider the properly differenced vectors denoted by X^j (j = U.S., Canada, Japan, UK, France, Germany, Italy) in Table 1. Since the vectors are stationary, they can be written as infinite moving average processes in the vector of structural shocks, $\boldsymbol{\epsilon} = [\epsilon_s, \epsilon_{ms}, \epsilon_{is}, \epsilon_{md}, \epsilon_{cf}]'$:

$$X_t = \sum_{i=0}^{\infty} A_i \epsilon_{t-i} = A(L)\epsilon_t, \tag{8}$$

where **A(L)** is a matrix whose elements are polynomials in the lag operator L. Denote the elements of **A(L)** by $\mathbf{a_{ij}(L)}$. The time path of the effects of a shock in ϵ_j on variable i after k periods can be denoted $\omega_{ij}(k)$. I also adopt the notation such that **A(1)** is the matrix of long-run effects whose elements are denoted $a_{ij}(1)$, where each element gives the cumulative effect of a shock in ϵ_j on variable i over time. Similarly, $\mathbf{A_0}$ is the matrix of impact effects and consists of $\omega_{ij}(0)$. The contemporaneous correlations among the variables is given by

$$HX_t = \epsilon_t \tag{9}$$

where $\mathbf{H} = A_0^{-1}$ and $\mathbf{A_0}$ is a nonsingular matrix. Recall that the objective of identification in a VAR is to discern the elements of the $\mathbf{A_0}$ matrix, which maps structural innovations to reduced form (composite) innovations. Identification through Choleski decomposition restricts $\mathbf{A_0}$ to be a lower triangular matrix, while some structural identification methods restrict the contemporaneous short-run interactions (the **H** matrix in Eqn. 9). Shapiro and Watson (1988) and Blanchard and Quah (1989) restrict the matrix of long-run effects, **A(1)**. Gali (1992) uses a combination of short-run and long-run restrictions on the **H**, $\mathbf{A_0}$, and **A(1)** matrices.

In the empirical model, just identification of the orthogonal innovations in ϵ requires 10 additional restrictions beyond the restrictions embedded in the variance–covariance matrix of reduced form innovations. To identify the shocks, I use the model above as a reference and make the following assumptions:

(i) Aggregate demand shocks in the broad sense (ϵ_{is}, ϵ_{ms}, ϵ_{md}) have no long-run effect on output. This is equivalent to $a_{12}(1) = a_{13}(1) = a_{14}(1) = 0$ in the **A(1)** matrix.

(ii) Monetary policy is transmitted to the real sector through real interest rates, which can be interpreted as monetary shocks (ϵ_{ms}, ϵ_{md}) and have no contemporaneous effects on output. While this restriction is not an explicit implication in the model above, it can be justified by the so-called outside lags (Gali 1992). Accordingly, aggregate demand does not directly react to monetary shocks but to changes they might bring about as they affect the real interest rate or the real exchange rate. This assumption serves to distinguish between real demand (*IS*) shocks and monetary shocks and is equivalent to $\omega_{12}(0) = \omega_{14}(0) = 0$ in the $\mathbf{A_0}$ matrix.

(iii) Contemporaneous homogeneity of a conventionally specified money demand. This is equivalent to $h_{43} = h_{45} = 0$ in the **H** matrix. This restriction distinguishes money demand shocks from money supply shocks.

(iv) Contemporaneous interest parity relation. This is equivalent to $h_{51} = h_{52} = h_{54} = 0$ in the **H** matrix.[3]

Note that since I am investigating the effect of the international monetary system, the money supply process is not restricted in any particular way. Allowing a general money supply rule can thus accommodate a host of monetary practices under the Bretton Woods and Modern Floating periods. The restrictions also can accommodate supply-side effects of the real exchange rate, as exogenous changes in the terms of trade may influence aggregate supply in the long run.

[3] Strictly speaking, this is weaker than contemporaneous uncovered interest parity because the real exchange rate is not required to adjust one by one to changes in the real interest rate. I recognize that capital flows shocks will be identified net of foreign real interest rates, and this assumption may be more appropriate for small countries.

3. Empirical Results

Under the maintained hypothesis that the international monetary regime may influence macroeconomic policy, it is essential to fit separate VARs to different monetary regimes. I consider a VAR for the Bretton Woods (1957.I–1973.I) period, and another VAR for the Modern Floating (1973.II–1996.I) period.[4]

First, I use likelihood ratio tests and residual diagnostics to determine the lag length of the VAR. In both periods, four lags are sufficient to produce approximately white-noise residuals. I then impose the identification restrictions outlined above in (i) through (iv) and recover the structural shocks under each exchange rate period.

The Incidence of Shocks

Table 2 reports the standard deviations of the shocks for the Bretton Woods and Modern Floating periods. Following Bayoumi and Eichengreen (1994), the table also presents measures of variability at the aggregate G7 level and a measure of dispersion. The first measure, under the G7 column, is the standard deviation of a weighted average of individual country shocks where the weights are obtained from each country's share in the G7 multilateral trade in 1970. The second measure, denoted *d*, measures the weighted standard deviation of individual country shocks around the G7 aggregate shock and gives an idea about dispersion.[5] First, consider supply shocks. There is some evidence that supply shocks decreased in magnitude for some countries from the Bretton Woods to the Modern Floating period. Standard deviations of supply shocks is significantly higher under the Bretton Woods period relative to the Modern Floating period in Japan, France, and Germany, while they are significantly lower only for Italy and the United States. The data indicate that the incidence of supply shocks for the United Kingdom and Canada did not significantly change from the Bretton Woods to the Modern Floating period. At the aggregate level, there seems to be no difference in the magnitude of shocks, although the dispersion measure indicates slightly lower dispersion in the Modern Floating period. This is in line with evidence presented by Bayoumi and Eichengreen (1994), who attributed the dispersion of negative supply shocks in the 1960s to the showdown in the postwar growth boom and the rise in labor militancy in a number of European countries. Notice the decrease in the incidence of supply shocks is pronounced for France and Germany.

Comparing the standard deviations of money supply shocks in the Bretton Woods and Modern Floating periods, the data seem to conform to conventional wisdom. All countries seem to have experienced a lower incidence of money supply shocks under the Bretton Woods period. This is consistent with the notion that fixed exchange rates constrain discretionary monetary policy. Articulated within the context of European Monetary System, this view considers fixed exchange rates as a commitment mechanism that "ties the policymaker's hand" and solves the time inconsistency problem (Giavazzi and Pagano 1988). The increase in the incidence of money supply shocks may also reflect the increase over time toward more activist monetary policies.

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[4] Some authors treat the closing of the Gold Window in August 1971 as the end of the Bretton Woods system. However, degrees of freedom considerations in a VAR framework preclude me from taking this approach. Moreover, the fixed rate regime in Canada was brief: 1962.I–1970.II; hence, Canadian results should be interpreted with some caution.

[5] Using trade weights in 1980 does not alter the results, as the maximum difference in the weights relative to 1970 is less than 2.5% for any country. Bayoumi and Eichengreen (1994) use GNP weights in 1970, which were converted to a common currency using purchasing power parity-based exchange rates.

Table 2. Standard Deviations of the Shocks

	United States	Canada	Japan	United Kingdom	France	Germany	Italy	G7[a]	d[b]
Bretton Woods Period (1957.I–1973.I)									
Supply	0.0058*	0.0112	0.0118*	0.0167	0.0152*	0.0167*	0.0119*	0.0057	0.0115
Money supply	0.0036*	0.0030*	0.0067*	0.0068*	0.0054*	0.0043*	0.0052*	0.0021	0.0045
IS	0.0074	0.0138*	0.0270*	0.0664*	0.0205*	0.0069	0.0137*	0.0133	0.0341
Money demand	0.0164	0.0485*	0.0328	0.0355*	0.0271	0.0218	0.0751*	0.0139	0.0327
Capital flows	0.0077*	0.0100*	0.0106*	0.0124*	0.0146*	0.0125*	0.0257	0.0041	0.0119
Modern Floating Period (1973.II–1996.I)									
Supply	0.0082	0.0117	0.0079	0.0191	0.0089	0.0110	0.0183	0.0057	0.0107
Money supply	0.0074	0.0053	0.0526	0.0133	0.0081	0.0110	0.0077	0.0075	0.0186
IS	0.0093	0.0419	0.0088	0.0390	0.0094	0.0070	0.0292	0.0093	0.0201
Money demand	0.0207	0.0257	0.0397	0.0603	0.0336	0.0234	0.0416	0.0146	0.0327
Capital flows	0.0338	0.0138	0.0433	0.0321	0.0165	0.0183	0.0305	0.0081	0.0281

[a] Entries under G7 are the standard deviations of weighted average shocks. The weights are calculated as the share of each country's total trade in 1970 in the total G7 multilateral trade.
[b] d is a measure of dispersion, which is based on the weighted standard deviations of individual country disturbances relative to the G7 weighted average disturbance. It is calculated as $d = \{(1/n)\,\Sigma[\alpha_i\,(\epsilon_i - \Sigma\alpha_i\epsilon_i)^2]\}^{0.5}$, where i refers to the country, n is sample size, and α is the trade share. Trade volumes are taken from the *Economic Report of the President* (1984).
* Individual country standard deviation in the Bretton Woods period is significantly different from the corresponding entry in the Modern Floating period at the 5% level.

It is known that the use of monetary policy to influence output and unemployment during the Bretton Woods years was rare. Moreover, standard deviations of money supply shocks within the Bretton Woods period point to a relatively lower incidence of U.S. money supply shocks. The United States has one of the lowest incidence of money supply shocks, which is consistent with the notion that the leader in a fixed exchange rate system sets the floor for monetary discretion. The aggregate measures confirm the increase in magnitude as well as dispersion from the Bretton Woods to the Modern Floating period.

The pattern of IS shocks in individual countries does not suggest a uniform experience across regimes. The United Kingdom, Japan, and France seem to have experienced a higher incidence of real demand (IS) shocks under the Bretton Woods period relative to the Modern Floating period. Note also that the United Kingdom, Japan, and France have the highest incidence of real demand shocks within the Bretton Woods period. On average, real demand (IS) shocks seem to be higher in magnitude under the Bretton Woods period and seem to have higher dispersion. This conforms to the traditional view of the collapse of the Bretton Woods system. Accordingly, the somewhat divergent incidence of real demand shocks and the resulting adjustment problems put additional strains on the Bretton Woods system.

As for money demand shocks, the results suggest a relatively more stable money demand under the Bretton Woods period with the exception of Canada and Italy. This is in line with empirical work on money demand, which has documented abrupt shifts in money demand functions starting in the mid-1970s. More than a result of the international monetary regime, many believe that the instability of money demand can be attributed to financial innovations and deregulatory measures that broke down the traditional payments patterns and made money and other liquid assets almost indistinguishable (Boughton 1991; Baba, Hendry, and Starr 1992).

The incidence of capital flows shocks is markedly higher under the Modern Floating period relative to the Bretton Woods period for all countries, except the difference is not significant in France and Italy. Rapid changes in real exchange rates and capital mobility have become a characteristic of the floating rate period. There is considerable evidence that the Bretton Woods system played a role in limiting nominal and real exchange rate movements, and the subsequent floating rate system increased the variability of real exchange rates (Stockman 1983; Mussa 1986).

Transmission of Shocks

A major argument in favor of a floating exchange rate system has been that it allows countries to pursue independent monetary policies. Table 3 presents empirical evidence on the correlation of the shocks; entries above the diagonal represent correlations in the Bretton Woods period and those below the diagonal pertain to the Modern Floating period.

Correlations of supply shocks indicate that country-specific supply shocks have prevailed in the Bretton Woods as well as the Modern Floating period. Money supply shocks for Japan and France, and the United Kingdom and Canada, are significantly correlated in the Bretton Woods period, while none of the correlations are significant in the Modern Floating period. Correlations of money demand shocks are significant for several pairs of countries in the Bretton Woods period while only the correlation between Germany and Canada is significant in the Modern Floating period. Correlations of IS shocks in both periods are significant for a number of countries, but these show no pattern across exchange rate regimes. As for bilateral correlations of capital flows shocks, the evidence indicates the preponderance of country-specific shocks

Table 3. Correlations of Shocks[a]

	United States	Canada	Japan	United Kingdom	France	Germany	Italy
Supply shocks							
United States	—	−0.18	0.13	−0.15	0.04	0.02	−0.15
Canada	0.12	—	−0.16	−0.20	−0.02	−0.18	0.02
Japan	0.05	0.06	—	−0.02	−0.03	0.19	−0.01
United Kingdom	0.07	0.08	0.06	—	−0.26*	0.01	0.03
France	0.37*	0.10	0.15	0.14	—	0.21*	0.06
Germany	−0.22*	−0.10	0.09	0.09	−0.30*	—	0.16
Italy	0.06	0.08	0.15	0.05	0.08	−0.08	—
Money supply shocks							
United States	—	−0.01	0.16	−0.08	0.14	−0.12	0.05
Canada	−0.16	—	−0.03	0.21*	0.10	0.17	0.04
Japan	0.11	−0.10	—	0.01	0.45*	0.02	−0.14
United Kingdom	0.05	0.04	0.16	—	−0.12	0.11	0.10
France	−0.09	0.18	0.02	−0.02	—	−0.00	0.07
Germany	0.08	−0.14	0.06	0.02	−0.14	—	−0.10
Italy	0.08	−0.16	−0.09	0.00	−0.07	0.12	—
IS shocks							
United States	—	−0.33*	−0.24*	0.25*	−0.07	−0.03	−0.05
Canada	0.24*	—	−0.01	−0.26*	−0.19	0.08	0.07
Japan	0.02	0.21*	—	0.05	0.17	−0.02	−0.12
United Kingdom	−0.13	0.10	0.08	—	0.34*	−0.02	−0.26*
France	0.22*	0.14	0.07	0.04	—	0.07	−0.24*
Germany	−0.06	0.06	−0.15	0.42*	−0.26*	—	−0.06
Italy	0.16	0.09	0.20*	0.21	0.20*	−0.21	—

Table 3. Continued

	United States	Canada	Japan	United Kingdom	France	Germany	Italy
Money demand shocks							
United States	—	−0.01	0.04	0.20	−0.24*	0.04	0.13
Canada	0.02	—	0.04	−0.05	0.09	−0.18	−0.25*
Japan	−0.02	0.09	—	−0.04	−0.15	0.23*	0.13
United Kingdom	−0.08	−0.13	0.12	—	0.06	−0.03	0.11
France	0.09	−0.03	0.13	0.19	—	0.24*	0.06
Germany	−0.01	0.22*	0.01	0.03	−0.15	—	0.30
Italy	−0.08	0.09	0.14	0.11	−0.14	0.04	—
Capital flows shocks							
United States	—	−0.08	0.46*	−0.07	−0.09	0.02	0.11
Canada	−0.30*	—	−0.35	−0.07	−0.05	−0.16	−0.05
Japan	0.54*	−0.28*	—	0.02	−0.10	0.01	−0.06
United Kingdom	−0.16	−0.05	0.05	—	0.07	0.16	0.07
France	0.11	−0.14	0.01	−0.31*	—	0.29*	−0.02
Germany	−0.13	0.06	0.04	0.23*	−0.17	—	0.13
Italy	0.05	−0.05	0.07	0.02	−0.05	0.07	—

[a] Correlations of shocks in the Bretton Woods period are above and those of the Modern Floating period are below the diagonal.
* Statistical significance at the 10% level.

Table 4. Correlations of Money Supply Shocks with Those of the United States at Some Leads and Lags[a]

	BW Period				MF Period			
	Lag	Corr.	Lead	Corr.	Lag	Corr.	Lead	Corr.
Canada	−8	−0.24	—	—	—	—	—	—
	−4	0.23	—	—	—	—	—	—
Japan	−3	0.21	—	—	—	—	—	—
United Kingdom	−2	0.25	+5	0.21	—	—	—	—
	−6	0.26	—	—	—	—	—	—
France	−4	0.22	+6	0.24	—	—	—	—
Germany	−6	0.30	—	—	—	—	—	—
Italy	—	—	+6	0.23	−3	−0.21	+8	0.24

[a] Only significant correlations at the 10% level are reported. The entries are the correlations of individual country money supply shocks with those of the United States at up to eight leads and lags.

except that the United States, Canada, and Japan seem to form a correlated group in the Modern Floating period.

The correlations of real shocks may have other implications. Exchange rate flexibility and the ability to conduct independent monetary policy are particularly important for countries facing idiosyncratic real shocks. Work on optimum currency areas inspired by Mundell (1961) often stresses the symmetry of real shocks as a precondition for enjoying the benefits of irrevocably fixed exchange rates. Similarly, high correlations between capital flows shocks indicate that real exchange rates are adjusting in the same direction, which is another criterion for an optimum currency area. To the extent that symmetric real disturbances prevail in the international economy, some argue that stabilizing the international financial system through international monetary coordination and stable exchange rates will make the foreign exchange market "informationally efficient in the social sense" (McKinnon 1988, p. 88). However, given the asymmetric nature of the real shocks in the Modern Floating period, there may be little to gain from stabilizing exchange rates and doing so may involve a considerable loss of freedom in achieving domestic policy objectives. These results are broadly supportive of recent similar studies (Eichengreen 1994).

It is known that transmission of macroeconomic disturbances may take time. To that end, I consider bilateral correlations of money supply shocks with those of the United States at up to eight leads and lags; the results are reported in Table 4. These results are supportive of monetary interdependence under the Bretton Woods period, as all countries have significant correlations with the United States in the Bretton Woods period while only Italy shares significant correlations with the United States in the Modern Floating period.

Collapse of the Bretton Woods System

Common explanations of the collapse of the Bretton Woods system emphasize demand-side factors. The spillover effects of U.S. inflationary policies associated with the Vietnam War, the War on Poverty, and growing divergence in aggregate demand policies in industrial countries are often blamed for the collapse of the Bretton Woods system. The U.S. dollar was a major reserve asset under the Bretton Woods system; it served as high-powered money for the United States as well as other countries. Because the United States could sterilize reserve flows while other countries could not, there were asymmetries in the adjustment between the United States and the rest of the world. This implies that even if U.S. demand shocks were small in magnitude, they may have contributed substantially to expansionary policies elsewhere. Table 2 confirms that the average magnitude and dispersion of real demand (*IS*) impulses was higher under Bretton Woods. Correlations in Table 4 show that after accounting for leads and lags, the Bretton Woods was conducive to transmission of money supply shocks. These results are in line with traditional explanations. My results also show that average magnitude and dispersion of supply shocks under Bretton Woods is at least as large as that under the subsequent float. Particularly, the standard deviation of supply shocks for the 1968–1972 subperiod is higher than that of the entire Bretton Woods period for all countries, except for Canada and Italy. These results confirm Bayoumi and Eichengreen (1994) in that traditional explanations regarding the collapse of the Bretton Woods system have unduly neglected supply-side factors. Overall, with limited exchange rate flexibility, limits to monetary discretion, and growing demand-and-supply shocks, major economies faced adjustment problems under Bretton Woods. These adjustment problems made maintaining fixed exchange rates costly, and may have helped bring the period to an end.

Alternative Specifications

To check whether results are sensitive to model specification and the degree of integration of variables, I estimate alternative models. First, given the strong prior on stationarity in the literature (Shapiro and Watson 1988), I consider a stationary real interest rate. Similarly, the growth of real money balances is difficult to reconcile with reasonable specifications of money demand, as it implies a nonstationary velocity growth. Hence, I consider stationary growth of real money balances for Japan in the Modern Floating period. As an alternative specification, I estimate a model identical to the benchmark model in Table 1, except for a stationary real interest rate and stationary growth of real money balances. Second, because the variables are integrated of different orders, I consider a symmetric model, $[\Delta y, \Delta i, i - \Delta p, \Delta m - \Delta p, \Delta q]$ for all countries. I estimate these models using the same set of identification restrictions as those used in the benchmark model. Although results of individual countries may differ, qualitative results are similar. First, standard deviations of money supply shocks under the Bretton Woods period are smaller, and second, the incidence of supply and real demand shocks under the Bretton Woods period are at least as large as the incidence under the Modern Floating period. Finally, money supply shocks are correlated under the Bretton Woods period, whereas there is little evidence of correlation under the Modern Floating period.

One may argue that empirical results above exclude a potentially important variable, namely the real world oil price. As a preliminary step, I test the significance of the real world oil price using a block causality test. In all cases, the real oil price is not significant, except for Canada and Japan under the Bretton Woods period. Surprisingly, the real world oil price is not significant in the Modern Floating period despite the severe oil shocks that occurred in the 1970s and 1980s. One likely explanation is that under the float, exchange rates acted as shock absorbers, while under Bretton Woods, commodity price changes did not occur fast enough to bring about relative price changes. Indeed, many recent studies have found that the real oil price is an important source of movements in real exchange rates in the post–Bretton Woods period (Zhou 1995; Dibooğlu 1996).

Since block causality tests capture the lagged effects real oil price changes, these tests may fail to account for the significance of contemporaneous effects of oil prices. To allow for that possibility, I augment the model with the change in real world oil price (Δrop, nominal crude

Table 5. Variance Decomposition of Output in the United States and Japan

	Bretton Woods						Modern Float					
	ϵ_s	ϵ_{ms}	ϵ_{is}	ϵ_{md}	ϵ_{cf}	ϵ_{op}	ϵ_s	ϵ_{ms}	ϵ_{is}	ϵ_{md}	ϵ_{cf}	ϵ_{op}
Japan												
1	48.3	0.0	28.9	0.0	9.1	13.8	90.2	0.0	8.6	0.0	0.0	1.4
4	64.9	0.6	24.5	1.3	8.7	10.6	96.8	0.1	1.9	0.1	0.2	1.5
8	71.4	0.4	18.4	2.8	7.0	9.3	97.4	0.1	0.8	0.4	0.3	1.2
16	75.2	0.3	15.8	3.3	5.4	8.8	95.7	0.1	0.3	0.5	2.5	1.2
24	78.3	0.2	13.9	3.1	4.4	8.4	95.4	0.1	0.2	0.3	3.1	1.0
United States												
1	20.7	0.0	77.7	0.0	0.0	1.6	30.6	0.0	66.5	0.0	2.4	0.5
8	10.0	0.6	78.7	8.9	1.8	5.2	79.3	2.0	17.4	0.4	1.0	4.9
16	21.8	3.7	54.9	11.5	8.1	13.2	89.6	0.9	7.9	0.4	1.1	4.7
24	52.5	3.9	30.4	7.7	5.6	11.5	91.5	0.6	5.4	0.3	2.2	3.9

oil price deflated by average G7 price level) and estimate the model [Δy, Δi, r, $\Delta m - \Delta p$, Δq Δrop] for the United States and Japan under the Bretton Woods and the Modern Floating periods.[6] In addition to the restrictions in i and ii above, I specify the remaining restrictions as follows:

(iii′) Money supply shocks have no long-run effect on the real exchange rate; $a_{42}(1) = 0$.

(iv′) Interest parity; $h_{51} = h_{52} = h_{54} = h_{56} = 0$.

(v) The real oil price is exogenous in the short run; $\omega_{61}(0) = \omega_{62}(0) = \omega_{63}(0) = \omega_{64}(0) = \omega_{65}(0) = 0$.

The latter restriction amounts to putting the real oil price as the first variable in the causal ordering. Qualitative results from this model regarding standard deviations of the shocks under fixed and flexible exchange rates are similar; here I report variance decompositions and impulse response functions regarding the behavior of output under each international monetary regime. Variance decomposition of output from this model for the United States and Japan is given in Table 5. The table indicates that supply and real demand (IS) shocks explain the preponderance of the variation in output, while oil price and capital flows shocks explain a moderate proportion of output in both countries under the Bretton Woods period. Under floating exchange rates, real demand shocks still play a dominant role in the short run in the United States, but not in Japan. Note that monetary shocks play a negligible role under both periods, except for money demand shocks under the Bretton Woods period in the United States. In both countries, real oil price and capital flows shocks under the Modern Floating period explain little of the variation in output. Although it is possible to allude to the literature on the role of real oil prices in economic fluctuations, I focus on the possible effects of the international monetary regime. The most important finding is that the relative importance of all shocks except supply shocks in explaining output declines relative to the Bretton Woods period. The relative decrease in the effectiveness of real demand shocks is compatible with the view that floating rates steepened the short-run Phillips Curve trade-off (Dornbusch and Krugman 1976). Accordingly, even if demand policies are not stable, fixed rates provided a framework that stabilized their effects. For example, an expansionary policy adopted in response to an incipient decline in economic activity under the

[6] The experiences of the United States and Japan are similar in that neither participated in fixed exchange rate arrangements after 1973, and data for both countries have comparable properties under both periods.

Bretton Woods period was more likely to raise output and employment, rather than wages, when it was not expected to persist. Alogoskoufis and Smith (1991) and Eichengreen (1993) found that expansionary demand policies produced larger increases in output and employment during the Bretton Woods period when inflation was not expected to persist, than subsequently.

The dynamic behavior of output in response to each shock can best be understood by examining the impulse response functions (IRFs). Figure 1 presents IRFs for the United States and Japan under each exchange rate period. IRFs indicate that in most cases the overidentifying restrictions implied by the theoretical model are satisfied. Supply shocks have positive and permanent effects on output in both countries under each period. IS shocks have a sizable short-run positive effect on output, except in Japan under the float. Real oil prices have negative effects on output, while capital flows shocks have small but positive effects. In most cases, money demand shocks have negative effects on output, as expected, while money supply shocks are negligible. IRFs confirm that relative importance of all shocks but supply shocks has declined from the Bretton Woods to the Modern Floating period. Notice that explaining output movements per se is beyond the scope of this paper; the important point is that there are patterns which may be explicable in terms of the exchange rate regime.

4. Conclusions

The collapse of the Bretton Woods system has led to a dramatic increase in nominal and real exchange rate volatility, which had not been anticipated. Given the implied effects on output and trade, it is important to investigate the role of the exchange rate system. Moreover, the debate surrounding a common currency in Europe has revitalized the question of comparative performance of international monetary regimes. Fixed exchange rates are associated with interdependence, but they may provide discipline and lower the degree of discretionary policies. It is also interesting to examine the role of differential incidence of real shocks across countries in the collapse of fixed exchange rate regimes such as Bretton Woods. In this paper, I try to provide evidence regarding the role of the international monetary system by using a disaggregated framework where the effects of the environment can be disentangled from those of economic policy. Using quarterly data from the Bretton Woods and the subsequent floating period and a set of long- and short-run restrictions consistent with an aggregate supply–aggregate demand model, I isolate supply shocks, money supply shocks, real demand (IS) shocks, money demand shocks, and capital flows shocks. I also examine the role of real oil prices. I then examine standard deviations and correlations of shocks to shed some light on the possible role of the international monetary regime.

Results show that the average magnitude and dispersion of supply shocks between the Bretton Woods period and the subsequent float is comparable; however, the average magnitude and dispersion of real demand shocks under Bretton Woods is higher. Money supply shocks have lower incidence and dispersion under Bretton Woods, while capital flows shocks are more prevalent under the float. The equally high incidence of supply shocks and relatively higher incidence and dispersion of real demand shocks under Bretton Woods probably made maintaining fixed rates costly.

Correlations of money supply shocks show that countries had limited scope for independent monetary policy under the Bretton Woods system, while flexible rates allowed for independent conduct of monetary policy. Bilateral correlations of the shocks show that countries faced mostly

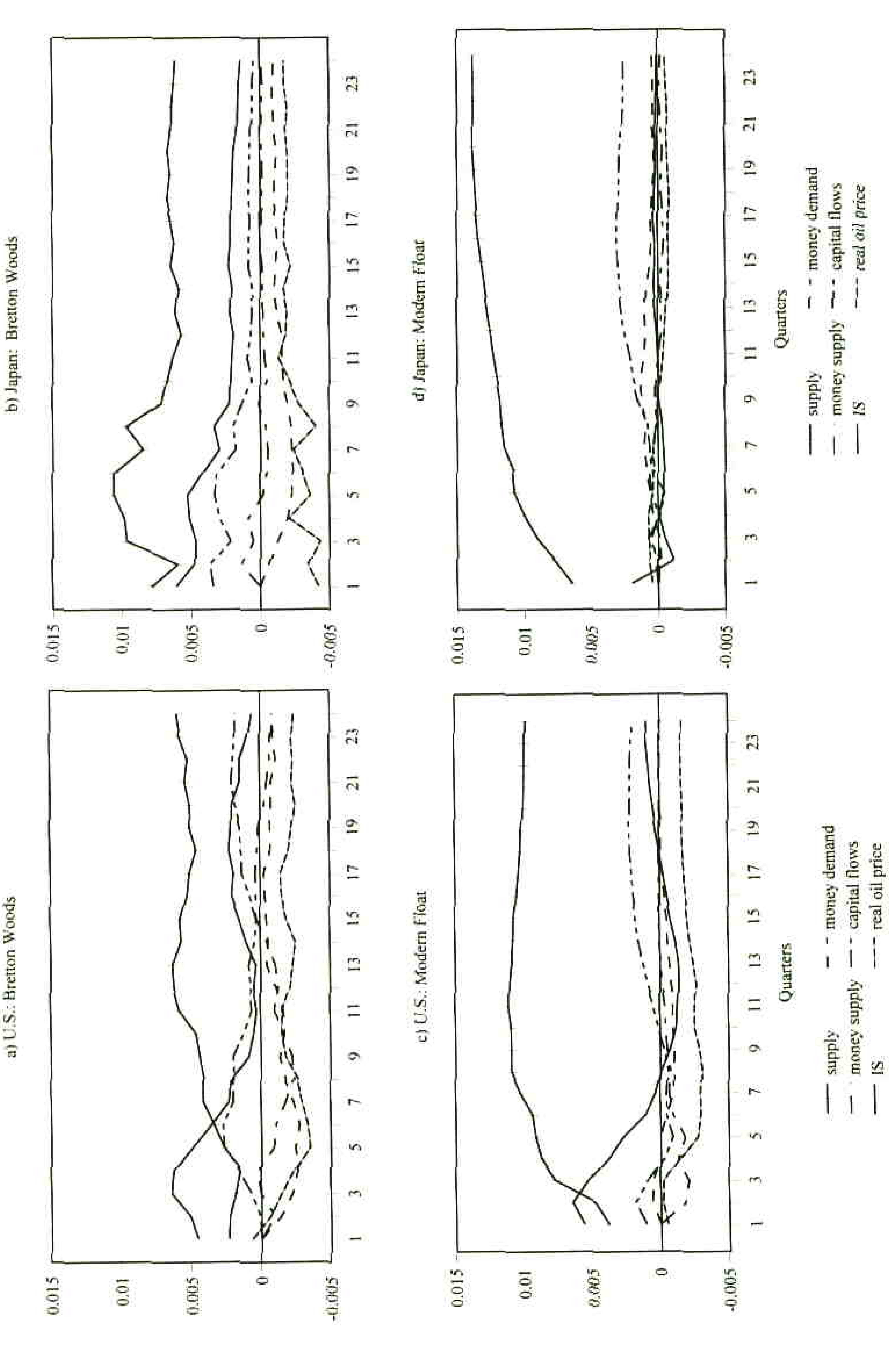

Figure 1. Impulse Response Functions (IRFs) of Output

country-specific real shocks under Bretton Woods as well as under the floating rate period. The implication is that with limited exchange rate flexibility and limits to monetary discretion, countries may have faced additional costs adjusting to the shocks under the Bretton Woods period. Overall, results show that the international monetary regime may pose important constraints to policymakers in open economies.

Appendix

Given capacity output and the money supply processes under a flexible exchange rate system, the solution for the expected nominal exchange rate and the expected price level can be derived from Equations 1–5. Taking expectations, the system can be expressed as

$$\begin{vmatrix} \beta_2 + \gamma\alpha_1 + \alpha_2 & -\beta_2 - \gamma\alpha_1 - \alpha_2 \\ (1 - \gamma) - k\beta_2 + \lambda & \gamma + k\beta_2 \end{vmatrix} \begin{vmatrix} s_t^e \\ p_t^e \end{vmatrix} = \begin{vmatrix} \gamma\alpha_1 & -\gamma\alpha_1 \\ \lambda & 0 \end{vmatrix} \begin{vmatrix} s_{t+1}^e \\ p_{t+1}^e \end{vmatrix} + \begin{vmatrix} \rho_t^e - \alpha_0 \\ m_t^e - k\rho_t^e \end{vmatrix}. \tag{A1}$$

where superscript e denotes expected value. This can be written compactly as $AY_t^e = BY_{t+1}^e + X_t^e$, or $Y_t^e = \Pi Y_{t+1}^e + CX_t^e$, where $C = A^{-1}$ and $\Pi = A^{-1}B$. Assuming rational expectations (e.g., $Y_t^e = E_{t-1}Y_t$), the forward-looking solution to the system in Equation A1 is

$$E_{t-1}Y_t = C\sum_{j=0}^{\infty} \Pi^j E_{t-1}X_{t-j}, \tag{A2}$$

where

$$C = \begin{vmatrix} c_{11} & c_{12} \\ c_{21} & c_{22} \end{vmatrix}; \quad c_{11} = \frac{\gamma + k\beta_2}{\Delta}; \quad c_{12} = c_{22} = \frac{1}{1 + \lambda}; \quad c_{21} = \frac{(1 - \gamma) - k\beta_2 + \lambda}{\Delta}$$

$$\Pi = \begin{vmatrix} c_{11}\gamma\alpha_1 + \lambda c_{12} & -c_{11}\gamma\alpha_1 \\ -c_{21}\gamma\alpha_1 + \lambda c_{12} & c_{21}\gamma\alpha_1 \end{vmatrix}; \quad \Delta = (\beta_2 + \gamma\alpha_1 + \alpha_2)(1 + \lambda).$$

The eigenvalues of Π are $\{z_1 = \lambda/(1 + \lambda),\ z_2 = \gamma\alpha_1/(\gamma\alpha_1 + \alpha_2 + \beta_2)\}$. Since both z_1 and z_2 are within the unit circle for finite values of the parameters, the system in Equation A2 is stable. Note that when the exogenous processes satisfy $E_{t-1}m_{t+j} = m_t$ and $E_{t-1}\rho_{t+j} = \rho_t$ for $j \geq 0$, the system will deviate from equilibrium only due to unexpected shocks.

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