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Commentary

MICHAEL BORDO PROVIDES US with a comprehensive, scholarly study of the history of the three main international monetary regimes: the gold standard, the dollar standard, and the floating exchange rate. He focuses on two important questions. First, which regime provided the best performance with regard to the levels of inflation and real growth? Second, what makes an international monetary regime viable?

Because I am not a historian, I will limit my comments to two areas. I will first discuss the comparative evidence on the performance of the three monetary regimes and use Bordo's statistics to infer a little more information on the role of demand shocks under the different regimes. Thereafter I will concentrate on the important issue of determining a monetary system's credibility. I find Bordo's thoughtful discussion of the issue useful. I should add, however, that sometimes he takes the literature too seriously—especially the affirmative literature on the European Monetary System (EMS). Nevertheless, Bordo forces us to consider which monetary system or standard, if any, can solve the credibility problem in terms of firmly anchoring market expectations about its viability.

WHICH REGIME PERFORMED BEST?

It is natural to evaluate the welfare implications of monetary regimes by asking what different regimes achieve with respect to the level and stability of inflation and real growth. Any monetary regime can be described as a mechanism or device that delivers an average rate of monetary expansion and a variance of money growth. With respect to economic performance, the essential difference is whether a particular regime provides governments with more or less freedom to manipulate the average rate of and the variance of monetary expansion. It follows that regime differences should be reflected in inflation levels and variances of inflation and per capita growth.

Table 1 draws from Bordo's tables 1 and 4. I consider the Group of Seven countries as a whole, the United States, Germany and France and concentrate on the three major periods: the pre-World War I gold standard, the Bretton Woods system of the 1950s and 1960s, and the floating exchange rate in place since the mid-1970s.[1] Note that, in contrast to Bordo, I do not separate out the favorable performance of the Bretton Woods convertible subperiod

[1]The Group of Seven countries are Canada, France, Germany, Italy, Japan, the United Kingdom and the United States.

Table 1

Inflation, Real Growth and Shocks in Different Monetary Regimes for the Group of Seven Countries, the United States, Germany and France[1]

	Gold Standard 1881-1913		Bretton Woods 1946-1970		Floating 1974-1989	
	Mean	Var	Mean	Var	Mean	Var
Inflation						
Mean Group of Seven	1.0	11.56	3.6	21.16	7.1	10.24
United States	0.3	9.61	2.4	6.76	5.6	5.76
Germany	0.6	6.76	2.7	16.00	3.3	1.69
France	−0.0	24.01	5.6	16.81	8.8	10.24
Per capita growth						
Mean Group of Seven	1.5	13.69	4.2	7.29	2.1	5.29
United States	1.8	26.01	2.0	7.84	2.1	7.29
Germany	1.7	8.41	5.0	10.89	2.1	3.61
France	1.5	21.16	3.9	4.41	1.7	2.25
Demand shocks						
Mean Group of Seven		8.64		7.91		6.26
United States		4.12		5.43		2.96
Germany		5.62		8.29		2.76
France		20.98		12.25		3.72
Supply shocks						
Mean Group of Seven		9.27		4.47		5.01
United States		14.52		2.37		3.76
Germany		5.38		7.02		1.93
France		14.06		3.06		2.31

[1]These data come from tables 1 and 4 in the Bordo article in this *Review*. The 1.69 estimated variance of inflation for Germany in the floating exchange rate period is based on a standard deviation of 1.3. This differs from the 1.2 standard deviation in Bordo's table 1 because of differences in rounding of the standard deviation.

The Group of Seven countries are Canada, France, Germany, Italy, Japan, the United Kingdom and the United States.

(1959-1970) in terms of inflation and output. The subperiod looked good on the surface; however, it was in fact the period when the breakdown of Bretton Woods was programmed. More generally speaking, for any regime we might find *ex post* a good looking subperiod.[2]

As Bordo and others have pointed out, the data permit the following observations:

- First, average inflation was negligible under the gold standard and highest under the floating exchange rate.
- Second, the variability of inflation, as well as that of real growth, was higher under the gold standard than under the floating exchange rate.
- Third, the Bretton Woods regime exhibited the highest variability of inflation, whereas output variability was closer to its level under the float than under the gold standard.

The first observation on average inflation performance is well known and understood. It is widely accepted that the classical gold standard prevented the manipulation of monetary expansion by enforcing a direct link between the base money stock, the national stock of gold and the balance of payments. Though devaluation was possible by raising the gold parity in national currency, it was rare. Thus the gold standard delivered the lowest average rate of inflation, given that the available gold stock did not grow much.

[2]As Anna Schwartz pointed out in the discussion, an evaluation of the EMS that bypasses the most recent period, when the EMS came close to collapse, would be seriously misleading.

At the other extreme, fiat money cum floating does not put any external constraint on domestic money production. Thus governments are free to use money production to collect inflation tax and to dampen the business cycle. The additional advantage to governments of the floating exchange rate is that the regime spares them the political cost of negotiating devaluation. In sum, the floating exchange rate is the monetary regime most conducive to inflationary policies. Finally, the Bretton Woods system was in between the gold standard and the floating exchange rate in that it started as a gold exchange standard but was permitted to degenerate into a pure fiat money standard (the dollar standard) during the early 1960s when the United States gold stock fell short of the value of outstanding dollar liabilities.

More interesting than the average inflation performance is the observed difference in the volatility of inflation and output growth among regimes. But to what extent can this volatility be attributed to the operation of the different monetary systems?

EXPLORING THE ROLE OF DEMAND SHOCKS

Apart from determining the level of inflation, monetary regimes differ with respect to nominal demand shock variability. I propose the following conjectures.

First, nominal demand shock variability is highest under the floating exchange rate and lowest under the gold standard. This reflects the differences in the limits to monetary discretion. Because the degree of monetary discretion is close to zero under the gold standard and unlimited under the floating exchange rate, we should observe that the variance of inflation was caused predominantly by nominal demand shocks under the floating exchange rate but by supply shocks under the gold standard.

Second, in a fixed-exchange rate system the system leader sets the floor for nominal demand shock variability. Consequently, for the Bretton Woods period we should observe that nominal demand shock variability was lowest in the United States. Similarly, during the floating rate period nominal demand shock variability should have been lower in Germany than in any other member country of the European snake or EMS.

Checking the empirical validity of these conjectures requires estimating the variance of nominal demand shocks. Bordo's study provides us with some valuable information in this respect. Following Blanchard and Quah (1989) and Bayoumi and Eichengreen (1992) in particular, he has estimated for each country and each monetary regime a bivariate vector autoregression (VAR) for the rates of change of the price level and output. The lower panel of table 1 provides the variances of the estimated aggregate supply and demand shocks.[3] Under the straightforward assumption that the distribution of real demand shocks was the same over the different monetary regimes, differences in demand shock variability can be attributed to the operational differences of the regimes.

The empirical findings are mixed. The data reject our first conjecture. For the Group of Seven countries demand shock variability was highest under the gold standard and lowest under the potentially permissive floating exchange rate regime. The most puzzling aspect is the high demand variability during the gold standard period because not only was monetary policy discretion constrained by the rules of the regime, but also fiscal discretion was negligible, at least by today's standards.

Our second conjecture, in contrast, is confirmed. Demand shock variability was lowest in the United States during the Bretton Woods period and in Germany during the float. Moreover, it can be shown for Germany using an F-test that the demand shock variance of the float differed significantly from its value under Bretton Woods at the 1 percent level of significance. In the United States the level of significance was 10 percent.

Though we have not seen any test statistics of Bordo's VAR estimates, let us assume that the estimates are clean. On this assumption we may use them to investigate the contribution of the aggregate demand shocks to the variability of inflation and output growth under the different monetary regimes. To do so requires a model of aggregate supply and demand to determine the unknown price elasticities of aggregate demand and supply.

Table 2 provides the bare bones of such a model. The model is written in logs and has a

[3]See Bordo's table 4.

Table 2
A Minimal Structure

(1) $y = \theta + \alpha (p - E_{-1} p)$ Output supply

(2) $y = \beta (m - p)$ Output demand

(3) $\theta = \theta_{-1} + s$ Productivity

(4) $m = m_{-1} + d$ Money stock

Solutions

(5) $\pi = p - p_{-1} = d_{-1} - \frac{1}{\beta} s_{-1} + \frac{1}{\alpha + \beta} [\beta (d - d_{-1}) - (s - s_{-1})]$

(6) $\Delta y = y - y_{-1} = s + \frac{\alpha}{\alpha + \beta} [\beta (d - d_{-1}) - (s - s_{-1})]$

Variances

(7) $\sigma_\pi^2 = \frac{\alpha^2 + \beta^2}{(\alpha + \beta)^2} \left[\sigma_d^2 + \frac{\sigma_s^2}{\beta^2}\right]$

(8) $\sigma_{\Delta y}^2 = \frac{\alpha^2 + \beta^2}{(\alpha + \beta)^2} \sigma_s^2 + \frac{2 (\alpha \beta)^2}{(\alpha + \beta)^2} \sigma_d^2$

Table 3
The Contribution of Demand Shocks to the Variability of Inflation and Real Growth[1]

	Gold Standard Variance			Bretton Woods Variance			Floating Exchange Rate Variance		
	Actual	Adjusted	Adjusted percentage of actual	Actual	Adjusted	Adjusted percentage of actual	Actual	Adjusted	Adjusted percentage of actual
Inflation									
Mean Group of Four	10.6	4.8	(45)	12.1	5.2	(43)	6.1	2.5	(41)
United States	9.6	3.5	(36)	6.8	4.2	(62)	5.8	2.4	(41)
Germany	6.8	3.3	(49)	16.0	6.0	(38)	1.7	1.5	(86)
France	24.0	12.0	(50)	16.8	7.4	(44)	10.2	2.4	(24)
Real growth									
Mean Group of Four	15.9	8.8	(55)	7.5	4.4	(59)	4.7	2.8	(60)
United States	26.0	13.8	(53)	7.8	6.0	(77)	7.3	4.2	(58)
Germany	8.4	5.2	(59)	10.9	5.8	(53)	3.6	2.6	(72)
France	21.2	13.1	(62)	4.4	2.6	(59)	2.3	0.8	(35)

[1]The Group of Four countries are Canada, France, Germany and the United States. The adjusted variance excludes the contribution of supply shocks.

Lucas-type supply equation and an aggregate demand equation. The evolution of prices and output is driven by productivity and the money supply (both modeled as random walks) with shocks d and s assumed to be independently distributed. The model's solutions [equations (5) and (6)] show that it meets the restrictions used in Bordo's VAR estimates. Supply shocks have permanent effects on the price level and output, whereas demand shocks have no permanent effect on output.

Given the variances of inflation, real growth, demand and supply shocks, equations (7) and (8) can be used to compute the slope coefficients in a p – y plane of aggregate demand, $-1/\beta$, and aggregate supply, $1/\alpha$. Solving by numerical iteration does not yield real solutions in all

cases—notably the Bretton Woods convertible subperiod.[4] Given the estimates of the slope coefficients, we can compute the contribution of the variance of aggregate demand shocks to the observed variances of inflation and real growth in table 3.

Table 3 presents for each monetary regime the measured variances of inflation and real growth, as well as adjusted variances, which exclude the contribution to volatility of the aggregate supply shocks. The numbers printed in parentheses indicate the percentage share in the measured variance of the contribution of the demand shock variance. Note that data from only four of the Group of Seven countries are included; data from Italy, Japan and the United Kingdom had to be removed because it was impossible to compute the slope coefficients for these countries (in at least one subperiod).

Table 3 can be summarized as follows:

- First, for the United States, the leader of the Bretton Woods regime, we find that the variances of inflation and real growth were dominated by the volatility of demand shocks during this period. About 62 percent of the variance of inflation and 77 percent of the variance of output growth can be attributed to the variance of demand shocks. Similarly, we find that for Germany under the floating regime the inflation and the output variance were dominated by demand shocks, which accounted for 86 percent of the inflation variance and 72 percent of the output variance.
- Second, for the four Group of Seven countries we find that demand shocks produced a higher inflation variance under Bretton Woods (5.2) than under the gold standard (4.8) or the floating exchange rate (2.5). The result probably reflects the differential performance of the two leading countries.
- Third, for the four Group of Seven countries as a whole, the variance of demand shocks did not dominate the inflation variance under any of the three monetary regimes. Its contribution never exceeded 45 percent. Thus we find over all regimes that the inflation variance was dominated by the volatility of aggregate supply shocks. This is a little surprising. Are we prepared to accept that systematic differences in the level of demand shock variability are not a characteristic feature of international monetary systems?

We cannot, however, rule out that these findings are statistical artifacts enforced by an inability to separate demand from supply innovations accurately in the VAR estimation. Bordo himself has noted that in some cases the overidentifying restriction (according to which positive supply shocks should permanently raise output and drive down the price level) is not satisfied.

Another indication of a possibly insufficient identification is the estimated change in the slopes of aggregate supply and demand between regimes. Figure 1 presents the average slopes of aggregate supply and demand for the four Group of Seven countries. What effect do we expect monetary regimes to have on these slopes?

Consider the model printed in table 4 which provides more structure than the model in table 2. Because the model is linear in logs, the size of the alpha and beta coefficients depends on the agents' price responsiveness, as well as on the share in output of the respective input in the production function or of the respective expenditure.

Comparing the regimes of the gold standard and Bretton Woods periods, we find that both aggregate supply and demand schedules were steeper under Bretton Woods. I would have expected the opposite on the argument that the economies were generally more open to international trade under Bretton Woods than before.

Comparing the Bretton Woods regime with the float, we observe that the aggregate supply schedule became steeper under the floating exchange rate but the aggregate demand schedule became more flat. The first observation is in line with the model in table 4 because the positive dependence of the nominal exchange rate (its log is denoted by e) on the domestic price level implies a steeper aggregate supply schedule. For the same reason, the demand schedule should also be steeper under floating. However, the data

[4]Of the up to four real solutions for each case, I chose the one which combines a negative slope of aggregate demand with a positive slope of aggregate supply.

Figure 1
G-4

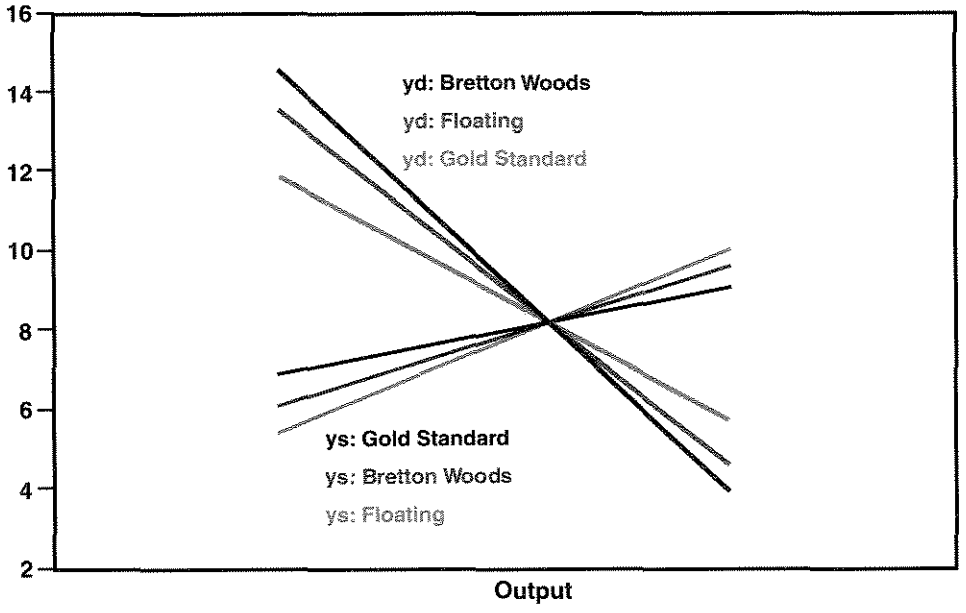

Figure 2
United States

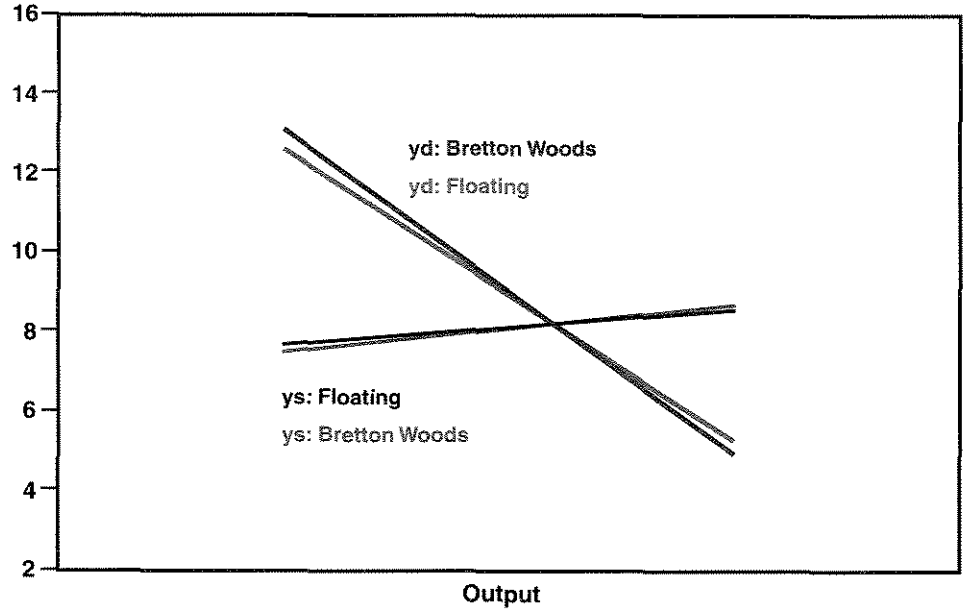

Table 4
Slopes and Exchange Rate Regimes

Model

(1) $y^d = \beta_0 g - \beta_1[i - (E_p{}^c{}_{+1} - p^c)] + \beta_2(p^* + e - p)$, $\beta_1 < \beta_2$

(2) $y^s = \theta + \alpha_1(p - E_{-1}p) - \alpha_2(p^{n*} + e - p)$

(3) $p^c = \gamma p + (1 - \gamma)(p^* + e)$

(4) $m = p + y - \lambda i$

(5) $i = i^* + Ee_{+1} - e$

Slopes

Fixed rates: $e = 0$

$$y^d: \frac{-1}{\beta_1\gamma + \beta_2}$$

$$y^s: \frac{1}{\alpha_1 + \alpha_2}$$

Flexible exchange rates

$$y^d: \frac{-1}{\left(\beta_1\gamma + \beta_2\right)\left(1 - \frac{\partial e}{\partial p}\right) + \beta_1\frac{\partial e}{\partial p}}$$

$$y^s: \frac{1}{\alpha_1 + \alpha_2\left(1 - \frac{\partial e}{\partial p}\right)}$$

do not comply. Also note that the United States data imply that both schedules are more flat under the float. See figure 2.

In sum, I agree with Bordo that his VAR estimates should be viewed with great caution. Moreover, because we are after the differential effect of monetary regimes, a serious drawback is that we cannot differentiate between nominal demand shocks, which we wish to study, and real demand shocks, which are irrelevant because they are not caused by the monetary regime.

Also, I must emphasize that we are studying international regimes, which implies that we cannot treat countries as independent entities. Monetary regime shocks are transmitted internationally. For example, a nominal demand shock produced by the Fed will show up in Germany as a demand shock that raises German output temporarily and German prices permanently. At the same time, however, the shock will show up in Germany as a supply shock, changing the relative price of imported raw materials. This reduces German output permanently and raises German prices permanently. Consequently, the identifying restrictions of Bordo's VAR estimates will classify the nominal demand shock from the United States as a supply shock in Germany.

In conclusion, I believe we have to make another, more sophisticated attempt at investigating the conjecture that international monetary regimes systematically differ with respect to the variability they impose on world economies.

THE CREDIBILITY PROBLEM

I now take up the fundamental question of which international monetary system, if any, can solve the credibility problem in the sense of firmly anchoring market expectations about the viability of the system?

Bordo's careful examination of the history of monetary regimes leads him to conclude that an international monetary system will be stable if its rules are credible. The rules will be credible if the member countries of the system are ready

to honor the rules. And member countries will honor the rules if there is a center country that enforces the rules. Accordingly, the classical gold standard did not break down because the United Kingdom, its center country, was committed to convertibility. In contrast, the United States, as the center country of Bretton Woods, was not committed to convertibility and maintenance of price stability. Bretton Woods consequently broke down. Finally, Germany's commitment to price stability made the EMS a successful and viable system. Unfortunately, the latter prediction held only until last September.

Though Bordo's reasoning makes a lot of sense, it fails to address two essential questions. First, by which means or under what conditions will the center country be able to enforce the rules? Second, and more fundamentally, what conditions are required to make the center country keep its commitment?

In my view, any international monetary system that is based on commitment to rules will be fragile. Commitment should be replaced by precommitment. The game theory reformulation of the pathbreaking analysis by Kydland and Prescott proves that governments cannot commit to price stability.[5] In contrast to commitment, precommitment does not depend on a government's good will or interest. Instead it is created by setting up an external mechanism that effectively ties the hands of current and future governments.

An international monetary regime will be stable and therefore durable if it provides the institutional constraints for a subgame-perfect supergame. The fundamental constraint is effective precommitment by all member governments. There are two types of precommitment: precommitment to price stability at home and precommitment to a fixed exchange rate vis-à-vis another currency. Consequently, we can design two alternative regimes.

A first regime resembles the EMS but commitment is replaced by precommitment. The center country precommits on price stability at home by providing its central bank with the constitutional status of independence from government. Elsewhere I have laid out a sufficient set of institutional elements that provides an incentive-compatible status of independence.[6] The other countries precommit on a fixed exchange rate vis-à-vis the center currency by writing the fixed exchange rate into the country's constitution as Sweden did during the gold standard.

The alternative international regime is created by an agreement that all governments precommit to price stability at home by providing their central banks with constitutional independence.

Which of the two regimes is preferred? The first regime provides price stability for all countries in the medium to long run. The precommitment to fixed exchange rates by n-1 members implies that idiosyncratic shocks will be distributed over member countries at full force, as was the case under the classical gold standard. Because fiscal policy is an important source of idiosyncratic shocks, the regime will hardly be attractive without a (enforceable) rule prohibiting public deficits.

The alternative regime of uniform precommitment to price stability at home might be rejected by some as a nonsystem. But semantics apart, the setup is not to be equated with unconstrained floating. The regime will provide nominal exchange rate stability though not fixity. Depending on the judgment of central bankers, the regime might evolve into an adjustable peg system where up to n-1 central banks unilaterally peg their currencies to the currency of a center country in a flexible manner. This means that in the advent of a sizable country-specific shock at home or in the center country, they will permit exchange rate adjusting. In contrast to the non-precommitted governments in Europe, the independent central bankers will have no interest in defending misaligned exchange rate parities.

In conclusion, the Bretton Woods system and the EMS broke down because both systems were built on unenforceable commitment instead of precommitment.

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[5]See Kydland and Prescott (1977).

[6]See Neumann (1991).