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Rules for Regulating Intervention under a Managed Float

Marsha R. Shelburn

INTERNATIONAL FINANCE SECTION
DEPARTMENT OF ECONOMICS
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1 INTRODUCTION

Since March 1973, the major industrialized nations have allowed the values of their currencies to fluctuate with market forces, subject to intervention at their discretion. Prior to that time, economists had expressed concern that a managed float would give rise to two kinds of problems. First, they anticipated some of the problems associated with freely fluctuating exchange rates. Second, they argued that optional intervention on the part of national authorities would introduce the potential for the manipulation of exchange rates in ways contrary to the interests of the international community. Since the advent of the managed float, some authors have praised its functioning while others have cited incidents "indicative of the nature of weaknesses in present foreign exchange arrangements" (Ethier and Bloomfield, 1978, p. 222).

Because of these concerns, there is a growing literature that proposes the imposition of regulations by an international group such as the International Monetary Fund permitting intervention by national authorities in the foreign-exchange market except under certain circumstances. The goal behind such proposals is to gain the benefits of allowing national authorities some control over their exchange rates while precluding unacceptable manipulation.

This Study examines and compares the potential performance of such rules when confronted by various intervention strategies. It uses a computer simulation model to describe the determination of a country's exchange rate under a managed float. The model includes a foreign-exchange market in which traders, speculators, and arbitrageurs participate, along with the country's monetary authorities. The country's domestic economy is described in the model insofar as is necessary to capture interactions between the foreign-exchange market and the internal economy. The various parameters and lag structures are based on empirical estimates drawn from the literature. Actual values of the variables in January 1970 are im-

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Professors Richard Froyen, Ed Howle, and Dennis Appleyard of the University of North Carolina at Chapel Hill provided valuable assistance with my Ph.D. thesis, on which this Study is based. A paper by Kenen (1975) and subsequent correspondence with him suggested the approach developed here. Kenen used a simulation model to compare alternative rules for intervention. This Study employs the same method (but a very different model) to compare alternative rules that limit intervention under certain circumstances.

posed initially. A preliminary simulation traces the path of the model as it converges to an equilibrium. In subsequent simulations, a disturbance is introduced and the paths of key variables are studied with alternative national strategies governing intervention and alternative international regulations limiting it.

The motives attributed to the country's monetary authorities are: indifference to exchange-rate change, desire to maintain the existing exchange rate, desire to avoid currency appreciation or depreciation, desire to cause gradual currency appreciation or depreciation, and desire to "lean against the wind."

The international regulations examined in the model never *require* intervention but instead limit it under certain circumstances. They are: a ceiling on the volume of intervention permitted per period, a limit on the duration of intervention in the same direction, a requirement that a country's reserve changes sum to no more than a specified limit over some time interval, and the "reference rate proposal."

2 THE MODEL

I begin by presenting in general form the equations of the model, neglecting lag structures and particular parameter values.[1] The model contains two countries—the home country, called "US," and the rest of the world, called "ROW." I call the home country "US" because convenience requires that it have some name and because parameters are drawn from empirical estimates for the United States and initial variable values are taken from data for the United States. In the presentation that follows, the absence of any subscript indicates use of the current value of that variable; the subscript -1 indicates that the variable is lagged only one period; the subscript $-j$ indicates that two or more lagged values of the variable appear in the equation. The variables are defined when introduced and again in the Appendix, in alphabetical order.

The US Goods Sector

In the US economy, real income is determined by real aggregate demand:

$$RY = RC + RI + \frac{GS}{P} + NEX, \qquad (1)$$

where RY is real income, RC is real consumption, RI is real investment, GS is nominal government spending, P is the price index, and NEX is the level of real net exports.

Real consumption is a function of real permanent disposable income, DYP, and the stock of real liquid assets, represented here by the real money stock:

$$RC = f\left(DYP, \quad \frac{MS}{P}\right), \qquad (2)$$

where MS is the nominal money stock (M1). Permanent disposable income is a weighted average of current and past levels of real disposable income:

[1] Because many equations include several variables with long lags, space constraints prohibit inclusion of the precise equation employed. The lag structures are important, however, in two respects: first, lags affect adjustment processes in the economy; the changes induced by any shock to the system do not occur instantaneously. Second, the inclusion of lags makes it possible to deal with many interactions between economic variables without having to solve a large simultaneous-equations system, because the model can be solved recursively.

$$DYP = f\left(\left(\frac{Y - DEP - TAX}{P}\right), \left(\frac{Y - DEP - TAX}{P}\right)_{-j}\right), \quad (3)$$

where Y is nominal income, DEP is capital-stock depreciation, TAX is taxes. (Nominal tax revenues grow at such a rate that real tax revenues increase 1.8 per cent annually.)

Real investment spending depends on the level of real income, the interest rate, R, and the level of real investment in preceding periods, as well as on the depreciation rate, SQ, and current and previous capital stocks, RK. Thus,

$$RI = f(RY_{-j}, R_{-j}, RI_{-j}, SQ, RK, RK_{-j}) . \quad (4)$$

SQ is held constant (at 0.00417 per month) throughout. The capital stock is defined by

$$RK = RK_{-1} - (SQ \cdot RK_{-1}) + RI_{-1} . \quad (5)$$

The third component of real income, real government spending, is controlled by the government in accord with political and economic goals. As explained below, I assume in reported results that government spending is adjusted monthly to keep real income growing at 1.8 per cent per year.

Net exports in real terms equal output of real exports, XPR, minus real import payments in the period. Thus

$$NEX = XPR - \frac{MP \cdot RM}{P} , \quad (6)$$

where MP is the value of import payments in foreign currency and RM is the exchange rate. (See equations 15, 19, and 32 below for export orders, import payments, and the exchange rate.)

The US Financial Sector

Although the home country is called "US," its currency is called "dollars," and parameters for the United States economy are used in the model, the financial sector is not a faithful representation of that country's financial sector. The real money stock is the policy target of the central bank, whose only tool is open-market operations. The assumed goal is a constant annual growth rate in the real money stock of 1.1 per cent: [2]

---

[2] The model assumes significant economies of scale in holding money. Though real income grows 1.8 per cent per year, the real money stock needs to grow only about 1.1 per cent per year. The money-demand equation in the model reflects estimates by Goldfeld (1973).

$$MS = 1.000912 \cdot \frac{MS_{-1} \cdot P}{P_{-1}} . \tag{7}$$

The model solves for the number of consols that must be sold to achieve the targeted money stock in the face of exchange-market intervention and imbalances in the government budget. The first step recognizes that the money stock is determined by the reserves available to the banking system:

$$MS = MS_{-1} + (MM \cdot \Delta \text{ bank reserves}) , \tag{8}$$

where MM is the money multiplier.[3] Equation (8) reflects several simplifying assumptions. First, nominal financial assets other than those in M1 are ignored. Second, intervention in the foreign-exchange market is conducted only by US authorities and affects bank reserves; it is not sterilized automatically by institutional arrangements. Third, budget deficits are completely monetized by central-bank bond purchases from the treasury. Thus, deficit spending increases bank reserves. Open-market operations, exchange-market intervention, and deficit spending are the only actions that affect bank reserves.

To achieve the desired nominal money stock implied by the real money-stock target, the central bank buys or sells consols priced at $1/R$ each. Therefore, the number of consols, GB, that must be sold is

$$GB = R \cdot MM\,(MS_{-1} - MS) + R\,(RSC_{-1} + GS - TAX) , \tag{9}$$

where RSC denotes the dollar value of US purchases (or sales if negative) of international reserve assets.

The demand for real money balances, denoted by RMD, is a function of real income and the interest rate:

$$ln\ RMD = f\,(ln\ RY_{-j},\ ln\ R,\ ln\ R_{-j}) . \tag{10}$$

The interest rate equates money supply and money demand:

$$MS = MD . \tag{11}$$

The US Price Level

The US price index, P, is given by

$$P = P_{-1}\,(1 + NF) , \tag{12}$$

[3] $MM = (C + 1)/(LR + C + X)$, where C is the desired ratio of currency to demand deposits, LR is the legally required ratio of reserves to demand deposits, and X is the desired ratio of excess reserves to demand deposits.

where NF denotes the inflation rate. The inflation rate is a function of the unemployment rate, U, the rate of growth of labor productivity, G, previous inflation rates, and the average rate of change of imported-goods prices in the preceding year, PM:

$$NF = f(1/U_{-j}, G_{-j}, NF_{-j}, PM) . \tag{13}$$

Unemployment follows "Okun's Law," which asserts (Okun 1970) that

$$U = 4.0 + \frac{1}{0.032} \cdot \frac{RYP - RY}{RY} , \tag{14}$$

where RYP is potential real output and is assumed to grow at 1.8 per cent per year from its initial level, which is estimated using equation (14) and the initial levels of U and RY.

US Trade

The exchange rate between the dollar and ROW currencies clears the foreign-exchange market. The transactions in that market are discussed below. Many of the equations are based on those employed by Kenen (1975).

Orders by ROW for US goods, XO, depend on the terms of trade, TT, and ROW real income, RYF. Thus,

$$XO = f(TT_{-j}, RYF_{-j}) , \tag{15}$$

where

$$TT = \frac{P}{PF \cdot RM} , \tag{16}$$

and PF is the price index in ROW. When an export order is placed, a dollar price is stated. Thus, the number of dollars demanded in a given period to pay for exports of home goods, XP, will depend on the price and quantities of previous orders:

$$XP = f(XO_{-j}, P_{-j}) . \tag{17}$$

Orders by US for ROW goods, MO, will vary with the terms of trade and US real income. Thus,

$$MO = f(TT_{-j}, RY_{-j}) . \tag{18}$$

When an import order is placed, a foreign-currency price is stated. Thus, import payments in foreign currency in any period will depend on previous orders and prices:

$$MP = f(MO_{-j}, PF_{-j}) . \tag{19}$$

To determine the number of dollars, DMP, that must be sold to obtain MP units of foreign currency, multiply MP by the exchange rate:

$$DMP = MP \cdot RM .\qquad (20)$$

Interest-Sensitive Capital Flows

Real capital flows occur in response to changes over time in the interest-rate differential between US and ROW. Adopting conservative estimates (Branson, 1970; Willett and Forte, 1969; Branson and Willett, 1972; Miller and Whitman, 1972), an increase in the differential by 1 percentage point raises the capital inflow by $780 million, regardless of the level of the differential. This is the parameter F in equation (21). The size of the flow increases, however, with increases in the rate of change of real wealth in US and ROW. (Wealth in ROW is assumed to grow at approximately the same rate as in US). Thus,

$$CA = F\left(1 + \frac{DW}{W_{-1}} + NF\right) \Delta (R - RF)_{-j} ,\qquad (21)$$

and

$$RCA = \frac{CA}{P} ,\qquad (22)$$

where CA is the volume of interest-sensitive capital flows into US, DW is the change in real wealth, W is real wealth, and RCA is the real value of interest-sensitive capital inflows. The change in real wealth equals the change in the real money stock minus real capital inflows plus the real value of new bond sales plus real net investment:

$$DW = \Delta\left(\frac{MS}{P}\right) - RCA_{-1} + \frac{GB_{-1}}{P_{-1} \cdot R_{-1}} + RI_{-1} - SQ \cdot RK_{-1} .\qquad (23)$$

Real wealth is thus:

$$W = W_{-1} + DW .\qquad (24)$$

Speculative Capital Flows

In any given period, exchange-rate speculators make a point estimate of the exchange rate for the next period, denoted by AR. In simulations used to compare alternative regulations in this paper, I assume that

$$AR = \frac{P}{PF} .\qquad (25)$$

Speculators rely on the concept of purchasing power parity in predicting the next period's exchange rate.[4]

The discrepancy between the current period's exchange rate, *RM*, and the rate anticipated for the next period, *AR*, indicates the size of speculators' prospective profits. For this reason, their desired short position in foreign currency, *SFD*, is

$$SFD = S\left(\frac{RM - AR}{AR}\right), \tag{26}$$

where S is a scalar whose size is related to export volume. This links the volume of speculation to the volume of trade. In all runs reported,

$$S = 60\, XO_{-1} \cdot P_{-1} . \tag{27}$$

Space limitations prevent comparisons of model performance with alternative specifications of S, though such comparisons would demonstrate the importance of speculative flows to the model. The desired short position in foreign currency has as its counterpart this desired long position in dollars, *SHD*:

$$SHD = SFD \cdot RM . \tag{28}$$

Speculators attain their desired foreign-exchange positions gradually; they purchase (or sell) dollars in an amount, *CSH*, equal to a fraction of the discrepancy between desired and actual holdings:

$$CSH = Q\,(SHD - SH_{-1}), \tag{29}$$

where SH_{-1} represents their actual long position in dollars at the end of the preceding period, and Q is the stock-adjustment coefficient. Initially, $SH = 0$, but thereafter,

$$SH = SH_{-1} + CSH . \tag{30}$$

Except for equations (25) and (27), the speculative behavior incorporated here is that described by Kenen (1975).

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[4] It would be worthwhile to compare performance of the model under several assumptions regarding the formation of exchange-rate expectations to see how speculative behavior affects the success of intervention strategies and regulations. I do not investigate this issue at length, but I did employ one alternative assumption in the free-float runs:

$$AR = \frac{1}{12}\sum_{j=1}^{12} RM_{-j} .$$

In runs with *AR* determined in this manner, there was greater volatility in exchange rates, export orders, and import payments than with the purchasing-power-parity assumption. The increased volatility is not surprising, since speculative responses will not modify trends in currency values as much when expectations are themselves sensitive to recent rate changes. Expectations based on purchasing-power parity are sensitive to exchange-rate trends only insofar as the trends affect relative price levels.

Official Intervention and Exchange-Rate Determination

The nominal dollar value of international reserves held by US's monetary authorities, denoted by *RES*, is

$$RES = RES_{-1}\left(1 + \frac{RM - RM_{-1}}{RM_{-1}}\right) + RSC \; . \tag{31}$$

The initial value of *RES* is set at a level high enough to prevent reserves from being exhausted during any of the runs reported. The volume of reserve purchases and sales will vary with the motivation of the government, the state of the economy, and international regulations, discussed below. Reserve assets in the model consist entirely of foreign currency, so that their dollar value changes when the exchange rate changes, as shown in equation (31).

The exchange rate in a given period clears the foreign-exchange market, given the trade and financial transactions above. The following equation is solved to arrive at the exchange rate:

$$XP - MP \cdot RM + CSH + CA - RSC + CON = 0 \, , \tag{32}$$

where *CON* is the constant that balances the equation for January 1970.[5]

The ROW Economy

Real income in ROW is assumed to grow at a constant 2.4 per cent per year (or 0.2 per cent per month). Thus,

$$RYF = (1.002)\, RYF_{-1} \; . \tag{33}$$

The growth rate of *RYF* is entirely arbitrary and could easily be altered, but it is essential to the particular equilibrium solution discussed in the next section.

The simulation model does not attempt to describe money supply and demand conditions in ROW. Rather, it reflects the fact that capital flows between US and ROW will affect ROW interest rates (*RF*):

$$RF = RF_{-1} + 0.64\, \Delta R_{-1} \; . \tag{34}$$

This equation reflects estimates made by Herring and discussed by Bryant (1975, p. 351).

By definition, the ROW price level is

$$PF = PF_{-1}(1 + NFF) \, , \tag{35}$$

[5] Equation (32) is quadratic in *RM*, and the method for choosing between its roots is the one employed by Kenen (1975, p. 115).

where *NFF* is the monthly inflation rate in ROW. The annual ROW inflation rate is constant at 10.225 per cent.

Equilibrium Values

As explained earlier, the purpose of this project is to analyze the impacts of official intervention in the foreign-exchange market and of regulations limiting such intervention. To isolate those impacts, I run the model until an equilibrium is established, then disturb the equilibrium and examine the path toward a new equilibrium under each alternative intervention strategy and regulation.

I consider equilibrium to exist when the key variables (the unemployment rate, the inflation rate, and the exchange rate) change less than 0.0083 per cent each month for five years. The total change in any key variable will then be less than 0.5 per cent over the five-year period. Obviously, the set of equilibrium values is not unique in that different assumptions about the conduct of fiscal or monetary policy or about ROW economic trends will result in very different paths for the key variables. There is thus nothing particularly significant about the equilibrium described here; it is simply that which results with the policy parameters and foreign trends I have chosen.

When the model starts, it contains built-in disturbances, because its equations include lagged variables whose values are specified from pre-January 1970 data for US and ROW. Long lags in many of the equations lead to slow adjustments, so that the model requires 349 months to reach equilibrium. This equilibrium is attained under the following assumptions: (1) government spending levels in US are adjusted each period to keep real income growing at 1.8 per cent per year and unemployment constant at 3.9 per cent; (2) real tax revenues grow at a constant 1.8 per cent annual rate; (3) the central bank, via open-market operations, keeps the growth rate of the real money stock constant at 1.1 per cent; (4) the ROW inflation rate is constant at 10.2 per cent per year and ROW real income grows at a 2.4 per cent annual rate.

When equilibrium is attained, the unemployment rate is 3.9 per cent, the annual inflation rate is 10.2 per cent, and the exchange rate is 0.918. At this point, I shock the model, study its behavior, and introduce the various intervention goals and regulations.[6]

[6] Though equilibrium is reached in period 349, programming convenience led me to wait until period 361 to begin my analysis. From this point on I therefore ignore the first 360

Introducing a Disturbance

The nature of a disturbance to the economic system affects both the ability of the monetary authorities to attain their goals and the performance of alternative regulations limiting intervention. We can envision any number of shocks, differing both in magnitude and in the variables they affect. I introduce just one in the runs reported here. In the first year, the foreign price level increases by 19.36 per cent, not at the equilibrium rate of 10.2 per cent per year. After the first year, ROW inflation is 10.2 per cent per year.

This disturbance creates a disequilibrium. International and domestic variables must adjust to the change in the relative price levels of US and ROW. The final outcome 240 periods after the disturbance begins is a new equilibrium in which the unemployment rate and the annual inflation rate have returned to 3.9 per cent and 10.2 per cent, respectively, but the exchange rate is 0.849. (Fiscal and monetary policies remain those described in assumptions 1 through 3 of the previous section.) The adjustment period is long because of the long lags in many equations of the model. The 8.13 per cent increase in the equilibrium value of the dollar accompanies the 8.05 per cent decrease in the US/ROW price ratio from its initial equilibrium level. This result is consistent with the theory of purchasing-power parity.

The path of adjustment is described in detail below, using several quantitative performance criteria. I focus on the first 120 of the 240 periods required to reestablish equilibrium because virtually all the adjustment takes place within that first interval. After period 120, actual values are very close to the new equilibrium values, and the remaining adjustments occur evenly and slowly.

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periods of the simulation, referring to period 361 as the first month of the ten-year period being studied.

3 COMPARING ALTERNATIVE INTERVENTION STRATEGIES AND REGULATIONS

How can we judge the success of a particular regulation limiting intervention or of a particular intervention strategy? Several performance criteria merit consideration.

Short-Run Variability

First, consider variability. Those significantly affected by exchange rates would prefer that the exchange rate be at the appropriate level and remain there. Disturbances in the economy will require exchange-rate adjustment, but most analysts favor arrangements that minimize "noise" in exchange rates and perhaps the abruptness of changes in the rate. I define noise in the exchange rate as changes that are soon reversed. These result in adjustment costs that might otherwise be avoided. Further, they increase the riskiness and uncertainty associated with international transactions.

The costs of adjustment to an abrupt exchange-rate change can be particularly high for those involved directly in international transactions. Also, an abrupt change can have substantial repercussions for the domestic economy. Spreading the same exchange-rate change over a longer period does not eliminate the adjustment costs, but it is likely to reduce those costs, other things equal.

To compare the extent of variability in any two simulations, I first calculate the mean squared error (*MSE*) of exchange rates from their twelve-month moving average in each simulation:

$$MSE = \frac{1}{114} \sum_{I=1}^{114} [RM(\mathrm{I}) - MAV(\mathrm{I})]^2 ,$$

where *MAV*(I) is the twelve-month moving average of the exchange rate, centered at period I.[1] The *MSE* is a good indicator of the presence of noise in the exchange rate.

A second statistic that is useful in examining the amount of variability is

[1] *MAV*(I) cannot be calculated for the last six periods of the run because future values of *RM*(I) are unknown.

the root mean square of successive differences in the exchange rate over the course of a simulation:

$$RRM = 100\sqrt{\frac{1}{120}\sum_{I=1}^{120}\left(\frac{RM(I-1) - RM(I)}{RM(I)}\right)^2}.$$

RRM reflects all exchange-rate changes but gives greater weight to large changes.

In addition to *MSE* and *RRM*, my program keeps count of the numbers of monthly exchange-rate changes falling in these intervals: (a) 0 to 1 per cent, (b) 1 to 2 per cent, (c) 2 to 3 per cent, (d) 3 to 4 per cent, (e) 4 to 5 per cent, (f) 5 per cent and greater. It also prints the size of the largest single change and the period in which it occurs.

Exchange-rate changes produce fluctuations in exports and imports. In fact, those fluctuations give rise to the concern about exchange-rate changes. For that reason, I examine fluctuations in trade flows. The summary statistics generated for exchange rates are also generated for export orders and import orders. First, my program calculates the root mean square of successive differences for export and import orders. Second, it generates frequency distributions for the absolute values of monthly changes in export and import orders.

Fluctuations in the exchange rate and resulting variations in exports and imports affect the domestic economies of the countries involved. The assumption built into my model that government spending is adjusted each period to maintain a constant rate of change in real income and a constant unemployment rate means that domestic economic effects will not produce variations in unemployment or real income. Instead, the fluctuations will be reflected in deviations from the usual path of government spending. The US inflation rate will also reflect exchange-rate changes. Thus, I examine the root mean square of successive differences in the monthly rates of change of government spending and in the inflation rate. I look, too, at the magnitude of the largest single monthly change in government spending and in the inflation rate.

Exchange-Rate Manipulation

When the monetary authorities are allowed to intervene in the foreign-exchange market, I need some measures of the extent of intervention. For this purpose, I record net reserve purchases in each run and the largest number of consecutive months of one-way intervention, as well as the average amount of intervention during that interval.

Currency Overvaluation or Undervaluation

The literature reflects concern that national authorities will seek artificially low or artificially high currency values when they are free to intervene. Competitive depreciation is a "beggar thy neighbor" policy that has resulted in periods of worldwide recession. Artificially high currency values have been sought to reduce inflationary pressures at home.

The extent of official intervention, however, is not an adequate indicator of the degree of currency overvaluation or undervaluation. Intervention may instead speed movement toward a new equilibrium value or reduce variation from the path toward that equilibrium. To determine whether intervention has, in fact, prolonged currency overvaluation or undervaluation, I compare the behavior of the exchange rate with that in the free-float run. Knowing the value to which the exchange rate eventually converges in the free-float run, I measure the size of the gap between the exchange rate in the final year of the run in question (its average value in the final twelve months) and in the final year of the free-float (the equilibrium rate). It is reported as

$$\text{Adjustment ratio} = \frac{\text{initial exchange rate} - \text{final exchange rate}}{\text{initial exchange rate} - \text{equilibrium exchange rate}} .$$

4 MOTIVES FOR OFFICIAL INTERVENTION

Having outlined the model and the criteria for evaluating performance, I now consider the possible motives for intervention by the national authorities and the resulting patterns of intervention.

Indifference to Rate Change

The simplest motive attributed to the national authorities in any run is total indifference to exchange-rate change. In other words, the monetary authorities accept the outcome of a free float. Since the model is in equilibrium when I begin my analysis, there is virtually no change in the exchange rate or other key variables (except those that grow at an equilibrium rate) until a shock is introduced. So I introduce the disturbance to the ROW inflation rate described above and examine the path of the model thereafter. This free-float run is then used as a benchmark for examining the consequences of intervention in other simulations.

To simulate a free float, equation (32) above is solved to determine the exchange rate for each period with *RSC* equal to zero. The values to which the variables converge are presented in Table 1 below. The initial equilibrium values are those to which the free-float model converges before the introduction of the shock; the new equilibrium values are those to which it converges following introduction of the shock.

As explained earlier, the growth rate of real income, the unemployment rate, and the inflation rate do not change between the two equilibrium states. Adjustments in fiscal policy hold the growth rate of real income and the unemployment rate constant throughout each run. The inflation rate does vary but returns to its previous level. The dollar appreciates 8.13 per cent as a result of the disturbance.

But what is the nature of the adjustment path? Table 2 presents relevant data. The *MSE* for the exchange rate is 0.000005, indicating that exchange rates adjust very smoothly over the course of the run. The chart of the exchange rate over the run verifies quick and smooth adjustment to the foreign price disturbance. Once that adjustment is completed, the exchange rate exhibits a very slight cyclical tendency as it approaches equilibrium.

The RMS (root mean square of successive differences) shows that the exchange rate changes at an average rate of about 0.25 per cent per month.

TABLE 1

CONVERGENCE VALUES OF KEY VARIABLES FOLLOWING THE FOREIGN PRICE DISTURBANCE UNDER A FREE FLOAT

Variable	Initial Equilibrium Value	New Equilibrium Value
Exchange rate	0.918	0.849
Annual inflation rate	10.2%	10.2%
Unemployment rate	3.9%	3.9%
Annual growth rate of real income	1.8%	1.8%

Again, the freely floating world does not appear to suffer erratic rate movements. The terms of trade move even less in the average period. Both export and import orders show average monthly changes of approximately 0.20 per cent. The US inflation rate changes by about 0.06 per cent per month, while the monthly change in real government spending averages 0.23 per cent. These small impacts on the US domestic economy are to be expected, since the nominal exchange rate bears the brunt of adjustment to the foreign price disturbance.

TABLE 2

ADJUSTMENT PATH AFTER THE DISTURBANCE UNDER A FREE FLOAT
(dollar figures in billions)

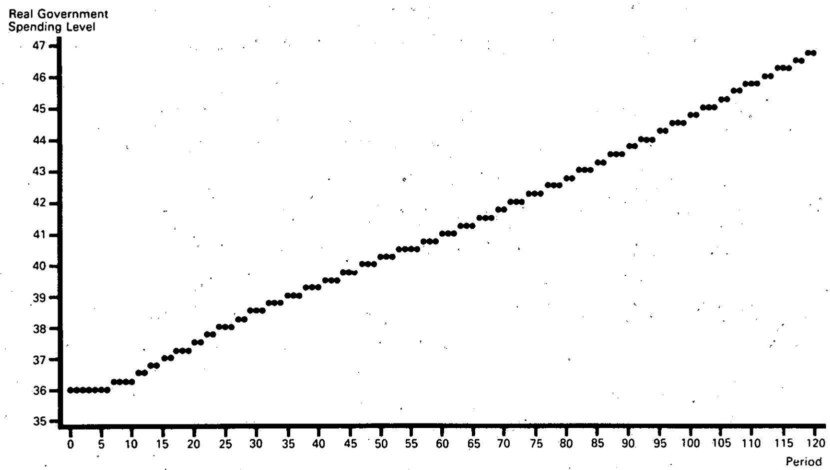
VARIABILITY			
Variable	*RMS*	*Average Value*	*No. of Changes Exceeding 1% per Month*
Exchange rate (MSE = 0.000005)	0.2526	0.849	0
Terms of trade	0.0397	1.060	0
Export orders	0.2022	$10.971	0
Import orders	0.2035	11.315[a]	0
Inflation rate	0.0627	10.0%	0
Government spending	0.2263	$41.056	0
ADJUSTMENT			
	Initial Value	*Equilibrium Value*	*Final Value*
Exchange rate (ratio = 1.029)[b]	0.918	0.849	0.847
Inflation rate	10.2%	10.2%	10.2%

[a] In billions of ROW currency units.

[b] Adjustment ratio $= \dfrac{\text{initial value} - \text{final value}}{\text{initial value} - \text{equilibrium value}}$.

FIGURE 1

REAL GOVERNMENT SPENDING FOLLOWING THE FOREIGN PRICE DISTURBANCE



The adjustment figures in Table 2 show that the exchange rate at the end of the run is very close to its equilibrium level, having overshot it slightly, so exchange-rate adjustment to the foreign price disturbance is nearly complete at the end of the ten-year period. The inflation rate has also returned almost exactly to its initial level, which becomes the new equilibrium level. Government spending shows a linear trend over the run (see Figure 1), so it, too, settles into a stable pattern as the run progresses.

To summarize, the model used here yields a free float that behaves well in the face of a foreign price disturbance. I make this point not to argue that free floats will always be well behaved or even that this model would behave as well with alternative disturbances or specifications. Rather, I want to note that there is little room for improvement over the free-float case. Accordingly, intervention can do little to smooth the path of the rate and the resulting adjustments in this model, but it may significantly change the path of adjustment.

Maintaining the Existing Rate

The second motive attributed to national authorities is the desire to maintain (peg) the existing nominal exchange rate. The performance of the "adjustable peg" Bretton Woods system suggests the relevance of such a motive. Under the Bretton Woods system, exchange rates were to be adjusted in case of a "fundamental disequilibrium," but countries exhibited great reluctance to alter them. Even today, many economists and some countries advocate a return to pegged rates. Their arguments are familiar and abundant, reflecting the desire to avoid both the adjustment costs associated with exchange-rate change and the uncertainties accompanying the possibility of change.

In my model, authorities intervene as necessary to keep the exchange rate in period I equal to that in period (I-1), provided they violate no international regulation. If a regulation constrains them, authorities intervene for as long and to the extent possible in the desired direction.

In the simulation incorporating this objective and with no international regulation, the exchange rate remains at 0.918 for the full ten-year period (see Table 3). Its average value is thus 7.6 per cent lower than in the free float. Net reserve purchases are $181.9 billion over the course of the run.

TABLE 3
INTERVENTION TO PEG THE RATE WITH NO REGULATION
(dollar figures in billions)

VARIABILITY			
Variable	*RMS*	*Average Value*	*No. of Changes Exceeding 1% per Month*
Exchange rate (MSE = 0.000000)	0.0000	0.9180	0
Terms of trade	0.2101	0.9937	0
Export orders	0.3408	$11.982	0
Import orders	0.2112	10.546[a]	0
Inflation rate	0.3211	10.2%	0
Government spending	0.2150	$40.067	0

ADJUSTMENT			
	Initial Value	*Equilibrium Value*	*Final Value*
Exchange rate (ratio = 0)[b]	0.918	0.849	0.918
Inflation rate	10.2%	10.2%	10.2%

RESERVE PURCHASES	
Longest interval of one-way intervention	119 periods
Average monthly reserve purchase during that interval	$ 1.5
Net reserve purchases during the entire run	$181.9

[a] In billions of ROW currency units.

[b] Adjustment ratio $= \dfrac{\text{initial value} - \text{final value}}{\text{initial value} - \text{equilibrium value}}$.

Authorities find it necessary to purchase reserves every period to prevent currency appreciation.

Since exchange rates cannot adjust to the foreign price disturbance, adjustment must occur elsewhere. The terms of trade vary more than in the free-float case (the *RMS* for terms of trade increases from 0.0397 to 0.2101), and this is reflected in export and import orders. Both are more volatile. Export orders are 9.2 per cent higher, on the average, and import orders 6.8 per cent lower than in the free-float case. US inflation increases slightly, averaging 0.2 percentage points higher than under the free float. Given the fiscal policy of maintaining a 1.8 per cent annual growth rate in real output, government spending is not as high as it would be in the absence of the undervalued currency. Net exports, boosted by the undervalued currency, provide more stimulus to the economy than they otherwise would.

In summary, pegging the exchange rate requires substantial intervention and prevents exchange-rate adjustment in response to a shock. Maintaining an artificially high exchange rate (artificially low dollar value) boosts export orders, cuts imports, and increases the variability associated with the terms of trade, export orders, import orders, and the inflation rate.

Avoiding Appreciation or Depreciation

Under certain circumstances, national authorities may wish to prevent the appreciation of their currencies, as in the face of strong lobbying efforts by the export sector of the economy or of concern over a generally depressed economy. Whatever the reasons for a bias against appreciation, the model can depict its operation. The exchange rate starts at 0.918 and monetary authorities will permit it to go above 0.918 (depreciation). But they will buy reserves to keep it from falling under 0.918, regulations permitting.

With the shock introduced in my analysis, the free-market exchange rate appreciates throughout the course of the simulation, ending at 0.847. Given that tendency, intervention that seeks to avoid appreciation is tantamount to intervention that seeks to peg the exchange rate. So the simulation result is identical to the pegged-rate result and requires no separate review.

If currency depreciation is viewed by political forces as an indication of economic weakness or as a significant inflationary factor, national authorities may wish to avoid depreciation of the domestic currency below its initial value. The disturbance introduced in runs reported here yields a free-market tendency for appreciation. Thus, no intervention is necessary to avoid depreciation; the simulation result for this goal is identical to the free-float result.

Causing Appreciation or Depreciation

National authorities may seek currency appreciation, perhaps hoping to reduce inflationary pressures at home. The magnitude and speed of the desired appreciation will vary with the goal. I model the behavior of national authorities seeking a 9 per cent appreciation stretched out smoothly over the ten-year simulation period. They compute the monthly rate of currency appreciation necessary to achieve the total amount of appreciation desired and set monthly exchange-rate targets accordingly. They intervene when necessary to attain their target rate, provided intervention is legal. The intervention will be in the form of a reserve purchase if the free-market value of their currency would be above their target. It will be in the form of a reserve sale if the market value would otherwise be below target.

Table 4 provides data on the simulation when authorities intervene in this manner and are not subject to international regulation. Exchange rates

TABLE 4
INTERVENTION TO CAUSE APPRECIATION WITH NO REGULATION
(dollar figures in billions)

VARIABILITY			
Variable	*RMS*	*Average Value*	*No. of Changes Exceeding 1% per Month*
Exchange rate (MSE = 0.000000)	0.0791	0.8763	0
Terms of trade	0.2000	1.0344	0
Export orders	0.2784	$11.386	0
Import orders	0.2646	10.989[a]	0
Inflation rate	0.3067	10.1%	0
Government spending	0.2363	$40.590	0
ADJUSTMENT			
	Initial Value	*Equilibrium Value*	*Final Value*
Exchange rate (ratio = 1.149)[b]	0.918	0.849	0.839
Inflation rate	10.2%	10.2%	10.0%
RESERVE PURCHASES			
Longest interval of one-way intervention			74 periods
Average monthly reserve purchase during that interval			$379.0
Net reserve purchases during the entire run			$ 56.9

[a] In billions of ROW currency units.

[b] Adjustment ratio = $\dfrac{\text{initial value} - \text{final value}}{\text{initial value} - \text{equilibrium value}}$.

move exactly along the targeted path, so that their *MSE* is zero and their *RMS* is very low. The dollar's value is actually below its free-market value for 90 of the 120 periods, because the target rate of appreciation is lower than the free-market rate. (The average value of the dollar during this run is approximately 3 per cent below that in the free-float run.) But in the last two and a half years of the run, US authorities do have to buy their currency to keep its value up to the targeted level. As the run ends, the dollar is overvalued by approximately 1 per cent. The terms of trade, the inflation rate, exports and imports, and government spending display more volatility than in the free-float run, but there are still no dramatic fluctuations in any of these variables.

Though such an effort would clearly conflict with international adjustment to the disturbance introduced in my simulation, officials might want to intervene to cause depreciation of the home currency. To examine the effectiveness of the alternative regulations in thwarting such efforts, I include this as a motive in one set of simulation runs. National authorities compute the monthly rate of currency depreciation necessary to yield a 10 per cent depreciation over ten years and set monthly exchange-rate targets accordingly. They intervene when necessary to attain their target rate, provided the intervention is legal.

Table 5 indicates performance when authorities seek depreciation with no international regulations to limit their intervention. The exchange rate, on the average, remains about 13 per cent above the free-float rate. As the simulation ends, the dollar is undervalued by about 16 per cent and authorities have spent almost $349 billion to purchase reserves. So this is a case of substantial exchange-rate manipulation. Export orders are, on the average, approximately 15 per cent higher with the artificially undervalued dollar than under the free float; import orders average 12 per cent less. Variability as measured by the *RMS* is higher for the terms of trade, for export orders, and for domestic inflation than in any other unregulated simulation. Table 5 shows that in four periods the level of export orders changed by more than 1 per cent and in three periods the inflation rate changed by more than 1 per cent. In all other unregulated runs, the variables changed less than 1 per cent in every period.

Leaning against the Wind

Well-intentioned national authorities may try to smooth the path of adjustment to any shock by "leaning against the wind." This phrase refers to intervention for the purpose of slowing rate change in either direction. To

TABLE 5
INTERVENTION TO CAUSE DEPRECIATION WITH NO REGULATION
(dollar figures in billions)

VARIABILITY			
Variable	*RMS*	*Average Value*	*No. of Changes Exceeding 1% per Month*
Exchange rate (MSE = 0.000000)	0.0791	0.9624	0
Terms of trade	0.2387	0.9549	0
Export orders	0.4140	$12.627	4
Import orders	0.1725	10.125[a]	0
Inflation rate	0.3381	10.3%	3
Government spending	0.1917	$39.499	0

ADJUSTMENT			
	Initial Value	*Equilibrium Value*	*Final Value*
Exchange rate (ratio = −1.255)[b]	0.918	0.849	1.005
Inflation rate	10.2%	10.2%	10.4%

RESERVE PURCHASES	
Longest interval of one-way intervention	120 periods
Average monthly reserve purchase during that interval	$ 2.9
Net reserve purchases during the entire run	$348.9

[a] In billions of ROW currency units.

[b] Adjustment ratio $= \dfrac{\text{initial value} - \text{final value}}{\text{initial value} - \text{equilibrium value}}$

simulate such behavior, I model national authorities who intervene whenever free-market forces tend to move the exchange rate more than 0.5 per cent in one month (unless the movement is in the opposite direction from the change in the preceding month). Reserves are purchased or sold as necessary to reduce the change in the exchange rate to half what it would have been in the free market.

Without regulation by international authorities, this intervention strategy results in the simulation described in Table 6. While the exchange rate at the end of the run is not significantly different from its free-float value or its equilibrium value, the path of adjustment is smoothed by the intervention. Both the *MSE* and the *RMS* for the exchange rate are lower here than under the free float. But the terms of trade are more volatile than in the free float, as are exports, imports, and the inflation rate. The last column

TABLE 6

INTERVENTION TO LEAN AGAINST THE WIND WITH NO REGULATION

(dollar figures in billions)

VARIABILITY			
Variable	*RMS*	*Average Value*	*No. of Changes Exceeding 1% per Month*
Exchange rate (MSE = 0.000002)	0.1691	0.8542	0
Terms of trade	0.0727	1.0556	0
Export orders	0.2085	$11.048	0
Import orders	0.2061	11.252[a]	0
Inflation rate	0.1110	10.0%	0
Government spending	0.2234	$40.973	0

ADJUSTMENT			
	Initial Value	*Equilibrium Value*	*Final Value*
Exchange rate (ratio = 1.015)[b]	0.918	0.849	0.848
Inflation rate	10.2%	10.2%	10.2%

RESERVE PURCHASES	
Longest interval of one-way intervention	10 periods
Average monthly reserve purchase during that interval	$ 1.2
Net reserve purchases during the entire run	$11.7

[a] In billions of ROW currency units.

[b] Adjustment ratio $= \dfrac{\text{initial value} - \text{final value}}{\text{initial value} - \text{equilibrium value}}$.

under "variability" in Table 6 shows, however, that abrupt change is not a problem for any variable.

Summary

In the simulations discussed so far there is no regulation of intervention. In each case, intervention, regardless of its goal, reduces both the *MSE* and the *RMS* of the nominal exchange rate from its free-float level. With intervention, however, the terms of trade show greater volatility than under the free float, and this results in more volatility of export and import orders.[1]

[1] When the purpose of intervention is to cause depreciation, import orders show a lower *RMS* than in the free float, but the *RMS* of export orders increases greatly over the one in the free-float run.

Looking at the two domestic economic variables reported, the inflation rate varies least under the free float and most when authorities intervene to cause depreciation. The average inflation rate is also highest in the latter run. It is lowest in the free-float and leaning-against-the wind runs. Government spending varies least when authorities seek depreciation and most when appreciation is the goal. The average level of government expenditures is lowest when authorities seek depreciation and highest under the free float. The undervalued currency increases exports and boosts import-substitute industries, so that achieving the real-growth-rate target requires less stimulus from fiscal policy.

The simulation results reported thus far support arguments for a free float. I think it fair to say that none of the intervention strategies modeled results in general improvement over the free-float run. (Admittedly, I have modeled only one sort of shock and cannot say that the result would always be the same.) But intervention may benefit certain groups. Thus, even if a free float is best, it may not be politically feasible. For that reason, I analyze the effectiveness of alternative international regulations to limit intervention.

5 REGULATIONS

The regulations that have been proposed to limit intervention in the foreign-exchange market reflect various approaches. The following regulations, which are representative of those approaches, have been built into the simulations reported below:

1. A ceiling on the volume of intervention allowed per period.
2. A limit on the duration of one-way intervention.
3. A requirement that a country's reserves be reconstituted over some time interval.
4. The "reference rate proposal."

Limiting Volume per Period

Mikesell and Goldstein (1975) proposed a ceiling on the volume of intervention per period. They suggested that some undesirable national intervention in the foreign-exchange market could be prevented by a regulation that would "limit the volume of intervention in either direction within a given period, say a month" (p. 5). But they did not say how much intervention should be permitted. My ceiling of $300 million per month (in 1970 dollars) is therefore entirely arbitrary.[1]

After describing the results when the ceiling is imposed on each of the intervention strategies, I draw general conclusions.

Intervention to peg the exchange rate. Comparison of Tables 7 and 3 shows that when the authorities attempt to peg the exchange rate, the ceiling on volume reduces net reserve purchases substantially from their level in the unregulated run (from $181.9 billion to $2.0 billion). It forces national authorities to accept exchange-rate adjustment, so that the real sector bears less of the adjustment burden. The *MSE* and *RMS* for the exchange rate increase, of course. But for the terms of trade, exports, and imports, variability is reduced by the regulation. As would be anticipated,

[1] To incorporate a ceiling into the model, statements are added to check whether the amount of intervention desired by national authorities (as determined by the goal of national authorities in that period) exceeds the ceiling. If it does not, the authorities can intervene in the planned amount. If it does, the authorities are required to reduce their intervention to the ceiling level, and equation (32) must be re-solved with that ceiling level of intervention included in order to determine the exchange rate.

TABLE 7
INTERVENTION TO PEG THE RATE WITH A CEILING ON INTERVENTION
(dollar figures in billions)

VARIABILITY			
Variable	*RMS*	*Average Value*	*No. of Changes Exceeding 1% per Month*
Exchange rate (MSE = 0.000004)	0.2250	0.8500	0
Terms of trade	0.0102	1.0600	0
Export orders	0.1953	\$10.987	0
Import orders	0.2012	11.302[a]	0
Inflation rate	0.0158	10.0%	0
Government spending	0.2249	\$41.037	0

ADJUSTMENT			
	Initial Value	*Equilibrium Value*	*Final Value*
Exchange rate (ratio = 1.044)[b]	0.918	0.849	0.846
Inflation rate	10.2%	10.2%	10.2%

RESERVE PURCHASES	
Longest interval of one-way intervention	94 periods
Average monthly reserve purchase during that interval	−\$0.025
Net reserve purchases during the entire run	\$2.0

[a] In billions of ROW currency units.

[b] Adjustment ratio $= \dfrac{\text{initial value} - \text{final value}}{\text{initial value} - \text{equilibrium value}}$.

the dollar appreciation (which was thwarted without the ceiling on intervention) reduces export orders and increases import orders. Domestically, the inflation rate varies much less with the ceiling and is 0.2 percentage points lower on the average. Government spending shows only slightly increased variability and is higher with the ceiling.

The overall impact of imposing the ceiling on volume is clearly positive in the context of the particular disturbance studied. In fact, although the unregulated peg was judged inferior to the free float, imposition of the ceiling yields *MSE* and *RMS* figures that are better than under the free float for every variable reported, and the adjustment ratio is not much worse.

Intervention to achieve currency appreciation. Comparison of Tables 8 and 4 shows that when the authorities want to achieve currency apprecia-

TABLE 8
INTERVENTION TO CAUSE APPRECIATION WITH A CEILING ON INTERVENTION
(dollar figures in billions)

VARIABILITY			
Variable	*RMS*	*Average Value*	*No. of Changes Exceeding 1% per Month*
Exchange rate (MSE = 0.000004)	0.2323	0.8585	0
Terms of trade	0.0512	1.0513	0
Export orders	0.1985	$11.131	0
Import orders	0.2132	11.186[a]	0
Inflation rate	0.0540	10.0%	0
Government spending	0.2259	$40.869	0
ADJUSTMENT			
	Initial Value	*Equilibrium Value*	*Final Value*
Exchange rate (ratio = 1.148)[b]	0.918	0.849	0.839
Inflation rate	10.2%	10.2%	10.0%
RESERVE PURCHASES			
Longest interval of one-way intervention			81 periods
Average monthly reserve purchase during that interval			$ 0.289
Net reserve purchases during the entire run			$18.5

[a] In billions of ROW currency units.

[b] Adjustment ratio $= \dfrac{\text{initial value} - \text{final value}}{\text{initial value} - \text{equilibrium value}}$.

tion, the ceiling on volume yields improvement over the unregulated case. Though the *MSE* and *RMS* for the exchange rate increase when the authorities can no longer maintain their desired path of appreciation, the variability of the terms of trade, exports, and imports is substantially reduced. The same is true for inflation and government spending. At the end of the run, the nominal exchange rate is at the same level as in the unregulated run, but intervention is one-third as high.

Intervention to achieve currency depreciation. The ceiling on volume has a dramatic impact when intervention is aimed at achieving depreciation. Comparison of Tables 9 and 5 shows that reserve purchases with the ceiling are about one-tenth as large as without regulation. Furthermore, the adjustment ratio is no longer negative. The exchange rate moves in the appropriate direction when the intervention ceiling is enforced and, at 0.861, is not far from its equilibrium value. Exchange-rate variability increases

TABLE 9

INTERVENTION TO CAUSE DEPRECIATION WITH A CEILING ON INTERVENTION
(dollar figures in billions)

VARIABILITY			
Variable	*RMS*	*Average Value*	*No. of Changes Exceeding 1% per Month*
Exchange rate (MSE = 0.000004)	0.2277	0.8630	0
Terms of trade	0.0328	1.0462	0
Export orders	0.2163	$11.183	0
Import orders	0.1891	11.143[a]	0
Inflation rate	0.0430	10.0%	0
Government spending	0.2205	$40.848	0

ADJUSTMENT			
	Initial Value	*Equilibrium Value*	*Final Value*
Exchange rate (ratio = 0.826)[b]	0.918	0.849	0.861
Inflation rate	10.2%	10.2%	10.2%

RESERVE PURCHASES	
Longest interval of one-way intervention	120 periods
Average monthly reserve purchase during that interval	$ 0.298
Net reserve purchases during the entire run	$35.7

[a] In billions of ROW currency units.

[b] Adjustment ratio = $\frac{\text{initial value} - \text{final value}}{\text{initial value} - \text{equilibrium value}}$.

with the ceiling regulation, no longer following a smooth linear path, but the terms of trade and exports are much more stable. There are no longer any periods in which export orders change by more than 1 per cent and the *RMS* drops from 0.4140 to 0.2163. Import orders, very stable in the unregulated run, do show slightly increased variability. Domestically, the average inflation rate falls, and its *RMS* drops from 0.3381 to 0.0430. Government spending and its *RMS* rise. Looking at Table 9 as a whole, I conclude that the ceiling on volume is highly effective in preventing the exchange-rate manipulation described in Table 5. At the same time, it reduces the magnitude and abruptness of change in the domestic and international economies.

Intervention to lean against the wind. Imposition of a ceiling on volume on an intervention strategy of leaning against the wind results in a drop in net reserve purchases from $11.7 billion to $3 billion (compare Tables 10

TABLE 10

INTERVENTION TO LEAN AGAINST THE WIND WITH A CEILING ON INTERVENTION
(dollar figures in billions)

VARIABILITY			
Variable	*RMS*	*Average Value*	*No. of Changes Exceeding 1% per Month*
Exchange rate (MSE = 0.000004)	0.2278	0.8499	0
Terms of trade	0.0178	1.0598	0
Export orders	0.1978	$10.991	0
Import orders	0.2002	11.299[a]	0
Inflation rate	0.0281	10.0%	0
Government spending	0.2244	$41.035	0

ADJUSTMENT			
	Initial Value	*Equilibrium Value*	*Final Value*
Exchange rate (ratio = 1.029)[b]	0.918	0.849	0.847
Inflation rate	10.2%	10.2%	10.2%

RESERVE PURCHASES	
Longest interval of one-way intervention	10 periods
Average monthly reserve purchase during that interval	$0.3
Net reserve purchases during the entire run	$3.0

[a] In billions of ROW currency units.

[b] Adjustment ratio $= \dfrac{\text{initial value} - \text{final value}}{\text{initial value} - \text{equilibrium value}}$.

and 6). The exchange rate varies more (*MSE* and *RMS* values both increase), but as the run ends it is not significantly different. The terms of trade, exports, and imports vary less, but their average levels are little different. Domestically, the inflation rate is more stable when the ceiling is imposed, but government spending varies to about the same degree. Neither changes substantially in size.

Summary. The ceiling on volume works satisfactorily no matter which intervention strategy is modeled. Its impact is most dramatic when the authorities seek to depreciate their currency despite market forces pushing in the other direction. In that instance, the ceiling is highly effective in limiting exchange-rate manipulation. In the other runs, the ceiling consistently forces the nominal exchange rate to bear more of the adjustment burden, reducing the variability of the terms of trade, exports, and imports. The internal economy generally appears a little more stable, too. Never does the ceiling operate unsuccessfully from the standpoint of one concerned with smooth internal and external economic adjustment.

Limiting the Duration of One-Way Intervention

The second regulation, limiting the duration of intervention by national authorities in any one direction, was also suggested by Mikesell and Goldstein (1975), as well as in International Monetary Fund documents. The Second Amendment of the Articles of Agreement of the IMF, which became effective on April 1, 1978, made legal "exchange arrangements of a member's choice" (Art. IV, Sec. 2(b)), and for the major industrialized countries that choice has proved to be a managed float. The same amendment also stated, however:

> The Fund shall exercise firm surveillance over the exchange rate policies of members, and shall adopt specific principles for the guidance of all members with respect to those policies. (Art. IV, Sec. 3(b))

In 1977, the Executive Board approved a set of principles to guide fund surveillance:

> . . . the fund shall consider the following developments as among those which might indicate the need for discussion with a member:
> (i) protracted large-scale intervention in one direction in the exchange market;
> (ii) an unsustainable level of official or quasi-official borrowing, or excessive and prolonged short term official or quasi-official lending, for balance of payments purposes.

The words "protracted" and "prolonged" in the IMF document indicate concern over the duration of intervention in one direction.

Similar concerns had earlier led Mikesell and Goldstein (1975, p. 5) to propose a requirement that "net reserve changes in a given direction could not persist for more than three consecutive months." I impose a six-month limit on the duration of intervention in one direction. If desired intervention in period I is in the same direction as actual intervention in the preceding six months, intervention must be zero in period I. (If the direction of intervention has varied or been zero in any one of the preceding six periods, there is no restriction of any sort in period I.)

When this rule is imposed, simulation results vary with the intervention strategy of national authorities.

Intervention to peg the exchange rate. Comparison of Tables 11 and 3 reveals the impact of the six-month limit on one-way intervention. With the intervention limit, the exchange rate varies, whereas in the unregulated

TABLE 11
INTERVENTION TO PEG THE RATE WITH A LIMIT ON THE DURATION OF INTERVENTION
(dollar figures in billions)

VARIABILITY			
Variable	*RMS*	*Average Value*	*No. of Changes Exceeding 1% per Month*
Exchange rate (MSE = 0.000002)	0.1636	0.8879	1
Terms of trade	0.2354	1.0222	0
Export orders	0.2834	$11.548	0
Import orders	0.2286	10.862[a]	0
Inflation rate	0.3630	10.2%	0
Government spending	0.2267	$40.462	0

ADJUSTMENT			
	Initial Value	*Equilibrium Value*	*Final Value*
Exchange rate (ratio = 0.710)[b]	0.918	0.849	0.869
Inflation rate	10.2%	10.2%	10.1%

RESERVE PURCHASES	
Longest interval of one-way intervention	6 periods
Average monthly reserve purchase during that interval	$ 3.0
Net reserve purchases during the entire run	$92.3

[a] In billions of ROW currency units.

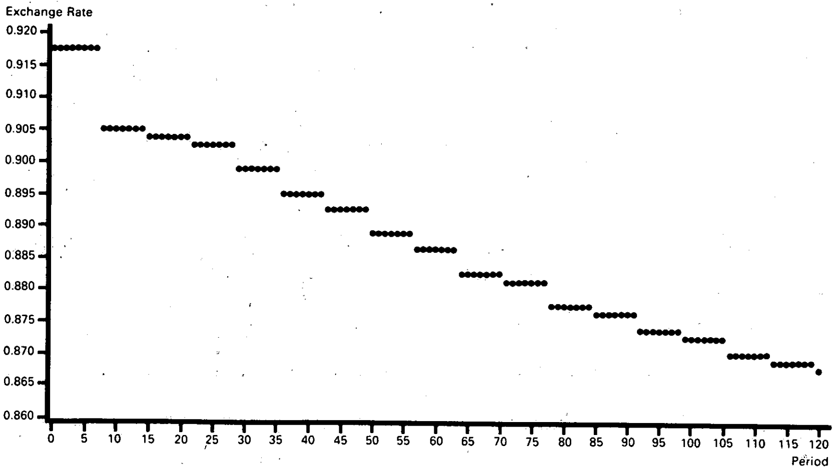
[b] Adjustment ratio = $\frac{\text{initial value} - \text{final value}}{\text{initial value} - \text{equilibrium value}}$.

run it was fixed by intervention throughout the simulation. With the limit, the largest single monthly change is 1.4 per cent. The limit clearly restricts intervention (net reserve purchases are reduced from $181.9 billion to $92.3 billion). The exchange rate, at the simulation's end, has moved 71 per cent of the way toward its new equilibrium and is now bearing part of the adjustment burden. Even so, the variability of the terms of trade, imports, the inflation rate, and government purchases increases slightly. Only exports become more stable. The monthly exchange-rate movement shown in Figure 2 reveals a step pattern that, though not abrupt, does not promote smooth adjustment in the real variables reported.

Intervention to cause appreciation. Once again, the intervention limit increases the magnitude and abruptness of exchange-rate change. Compar-

FIGURE 2

THE EXCHANGE-RATE PATTERN WITH INTERVENTION TO PEG THE RATE AND A LIMIT ON THE DURATION OF INTERVENTION



ison of Tables 12 and 4 shows higher *MSE* and *RMS* values for the exchange rate in the regulated case, though the final exchange rates are virtually identical. Furthermore, the frequency of exchange-rate changes in excess of 1 per cent per month increases from 0 to 2. These figures would not necessarily indicate inferior performance if real variables showed increased stability. But we find that the volatility of the terms of trade also increases, while exports and imports show only slightly reduced *RMS* values. The inflation rate becomes significantly more volatile with the intervention limit, and government spending varies a little more. Thus, the regulation results in generally inferior performance with this intervention goal.

Intervention to cause depreciation. The limit on the duration of intervention has its most dramatic impact when the goal of intervention is to cause depreciation. Comparison of Tables 13 and 5 shows that the *MSE* for the exchange rate increases from 0.000000 in the unregulated run to 0.000008. The *RMS* for the exchange rate increases from 0.0791 to 0.4235. Figure 3 shows the pattern formed by the exchange rate as the regulation prevents intervention every seventh period. Yet the added instability is not accompanied by any significant reduction in currency manipulation. The exchange-rate adjustment ratio in Table 13 shows that, when the run ends, the exchange rate has been pushed by intervention away from its new equilibrium, just as in the unregulated case. As the exchange rate follows a

TABLE 12

INTERVENTION TO CAUSE APPRECIATION WITH A LIMIT ON THE DURATION OF INTERVENTION

(dollar figures in billions)

VARIABILITY			
Variable	*RMS*	*Average Value*	*No. of Changes Exceeding 1% per Month*
Exchange rate (MSE = 0.000003)	0.1982	0.8761	2
Terms of trade	0.2700	1.0346	1
Export orders	0.2777	$11.382	0
Import orders	0.2641	10.991[a]	0
Inflation rate	0.4075	10.1%	2
Government spending	0.2409	$40.594	0
ADJUSTMENT			
	Initial Value	*Equilibrium Value*	*Final Value*
Exchange rate (ratio = 1.148)[b]	0.918	0.849	0.839
Inflation rate	10.2%	10.2%	10.0%
RESERVE PURCHASES			
Longest interval of one-way intervention			6 periods
Average monthly reserve purchase during that interval			$ 3.5
Net reserve purchases during the entire run			$56.3

[a] In billions of ROW currency units.

[b] Adjustment ratio $= \dfrac{\text{initial value} - \text{final value}}{\text{initial value} - \text{equilibrium value}}$.

more erratic path, so do the terms of trade, with an *RMS* that has more than doubled. The *RMS* for inflation approximately doubles as the inflation rate changes by more than 1 per cent in five months of the run. Although *RMS* values for exports and imports do not change significantly, government spending is a little more erratic. Thus, the duration limit performs poorly once again.

Intervention to lean against the wind. Even in the unregulated run reported in Table 6, intervention to lean against the wind does not substantially change the free-float results. It is therefore not surprising that the imposition of a limit on the duration of intervention has little impact with this intervention goal. As Table 14 shows, the exchange rate becomes somewhat more erratic but is little different at the end of the run from that in the unregulated case. The *RMS* for the terms of trade, the inflation rate,

TABLE 13

INTERVENTION TO CAUSE DEPRECIATION WITH A LIMIT ON THE DURATION OF INTERVENTION

(dollar figures in billions)

VARIABILITY			
Variable	*RMS*	*Average Value*	*No. of Changes Exceeding 1% per Month*
Exchange rate (MSE = 0.000008)	0.4235	0.9614	2
Terms of trade	0.4796	0.9558	1
Export orders	0.4122	$12.611	4
Import orders	0.1723	10.135[a]	0
Inflation rate	0.6758	10.3%	5
Government spending	0.2201	$39.514	0
ADJUSTMENT			
	Initial Value	*Equilibrium Value*	*Final Value*
Exchange rate (ratio = −1.234)[b]	0.918	0.849	1.003
Inflation rate	10.2%	10.2%	10.4%
RESERVE PURCHASES			
Longest interval of one-way intervention			6 periods
Average monthly reserve purchase during that interval			$ 4.9
Net reserve purchases during the entire run			$344.2

[a] In billions of ROW currency units.

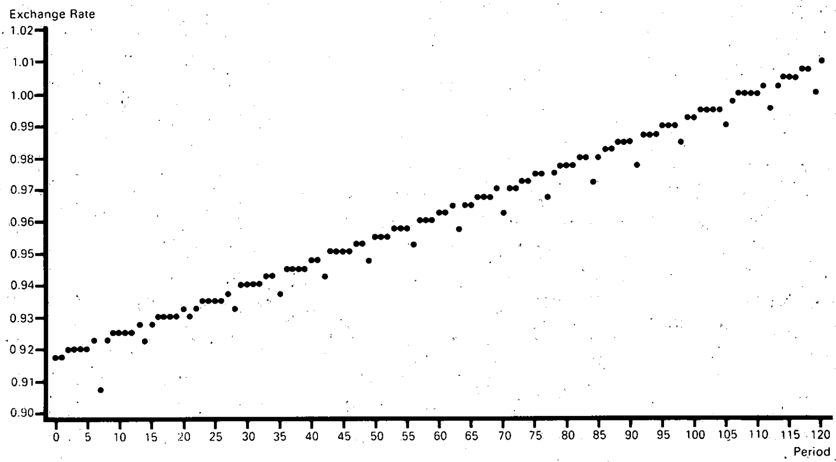
[b] Adjustment ratio $= \dfrac{\text{initial value} - \text{final value}}{\text{initial value} - \text{equilibrium value}}$.

exports, and imports is slightly reduced, while the *RMS* for government spending is unchanged. Net reserve purchases over the run fall by about 41 per cent. Thus, the duration limit on intervention may constitute an improvement over the unregulated case in this instance, but the improvement is certainly not substantial.

Summary. The performance of the regulation limiting the duration of one-way intervention in simulations of alternative intervention strategies forces me to conclude that this is an unsatisfactory regulation. Its performance is worst when it is needed most. If currency manipulation is substantial, a sudden end to it after six months necessarily compels a large change in the exchange rate. This is most apparent when the intervention goal is currency depreciation in the face of market forces for appreciation. Figure 3 shows the path of exchange rates in that run. Of course, it is possible that

FIGURE 3

THE EXCHANGE-RATE PATTERN WITH INTERVENTION TO CAUSE DEPRECIATION AND A LIMIT ON THE DURATION OF INTERVENTION



national authorities subject to such a regulation would adopt a practice of gradually phasing out intervention prior to the month in which the limit took effect. In that case, erratic rates should be less of a problem.

Requiring Reconstitution of Reserve Position

Another alternative derived from the work of Mikesell and Goldstein (1975) is that "monetary authorities might be required to restore their original reserve position within a reasonable period of time or at least move strongly in that direction" (1975, p. 5). The authors do not suggest any particular time period as "reasonable."

I specify a version of this proposal which requires that the net reserve change be $1 billion or less at least once every two years and that corrective action be initiated whenever the net change in the reserve position of a country has not been as low as $1 billion at some point in the preceding twelve months. The corrective action undertaken monthly must be sufficient to bring the net reserve change down to $1 billion by the end of the second year. This is the only regulation examined in this Study that would ever *require* intervention. In that respect, it does not belong here. Its purpose, however, is to limit intervention, and in that sense it does qualify for consideration.

The monetary authorities of a nation would not be likely to get them-

TABLE 14

INTERVENTION TO LEAN AGAINST THE WIND WITH A LIMIT ON THE DURATION OF INTERVENTION

(*dollar figures in billions*)

	VARIABILITY		
Variable	*RMS*	*Average Value*	*No. of Changes Exceeding 1% per Month*
Exchange rate (MSE = 0.000003)	0.2083	0.8518	1
Terms of trade	0.0623	1.0578	0
Export orders	0.2002	$11.017	0
Import orders	0.2012	11.278[a]	0
Inflation rate	0.0927	10.0%	0
Government spending	0.2234	$41.007	0
	ADJUSTMENT		
	Initial Value	*Equilibrium Value*	*Final Value*
Exchange rate (ratio = 1.029)[b]	0.918	0.849	0.847
Inflation rate	10.2%	10.2%	10.2%
	RESERVE PURCHASES		
Longest interval of one-way intervention			6 periods
Average monthly reserve purchase during that interval			$1.1
Net reserve purchases during the entire run			$6.9

[a] In billions of ROW currency units.

[b] Adjustment ratio = $\frac{\text{initial value} - \text{final value}}{\text{initial value} - \text{equilibrium value}}$.

selves into a situation in which such a regulation, if imposed, would be binding. If it became binding, officials might be forced to intervene in the direction opposite to that desired. It seems more likely that intervention under this regulation would reflect the deterrent effects of the regulation rather than its direct effects. So instead of modeling the regulation itself, I model those deterrent effects.

I assume that monetary authorities will act as follows: (1) Estimate the amount of intervention required to achieve the country's exchange-rate goal. (2) Calculate the maximum amount of intervention, *MAX*, that would be permitted before the country reached the limit set by the regulation. (3) If the desired amount of intervention in the current month is smaller than 0.5 *MAX*, intervene as desired. If not, intervene in an amount equal to 0.5 *MAX* in the desired direction. In following such guidelines, authorities would ensure, first, that the regulation would never force them to intervene in the direction opposite to that desired and, second, that they could always intervene in the next month in an amount as large as in the current month.[2]

Simulation results confirm that if the authorities respond to the reconstitution rule as thus envisioned, it exerts a very powerful limit on intervention. I examine the rule's impact with each intervention goal.

Intervention to peg the exchange rate. Table 15 presents summary statistics for the run in which national authorities, wishing to peg their exchange rate, find themselves subject to the reconstitution regulation. Table 15 shows a higher *MSE* and a higher *RMS* for the exchange rate, as the desire to peg

TABLE 15
INTERVENTION TO PEG THE RATE WITH REQUIRED RECONSTITUTION OF RESERVES
(*dollar figures in billions*)

VARIABILITY			
Variable	*RMS*	*Average Value*	*No. of Changes Exceeding 1% per Month*
Exchange rate (MSE = 0.000004)	0.2452	0.8480	0
Terms of trade	0.0382	1.0613	0
Export orders	0.2024	$10.967	0
Import orders	0.2010	11.319[a]	0
Inflation rate	0.0577	10.0%	0
Government spending	0.2250	$41.064	0
ADJUSTMENT			
	Initial Value	*Equilibrium Value*	*Final Value*
Exchange rate (ratio = 1.015)[b]	0.918	0.849	0.848
Inflation rate	10.2%	10.2%	10.2%
RESERVE PURCHASES			
Longest interval of one-way intervention			36 periods
Average monthly reserve purchase during that interval			$0.02
Net reserve purchases during the entire run			−$0.2

[a] In billions of ROW currency units.

[b] Adjustment ratio = $\frac{\text{initial value} - \text{final value}}{\text{initial value} - \text{equilibrium value}}$.

[2] This rule would have them approach the limit asymtotically if they desired to intervene month after month.

is thwarted, than in Table 3, with no regulation. But the variability is not even as great as in the free-float run (Table 2). The variation reflects movement toward the new equilibrium rate, as indicated by the adjustment ratio of 1.015 and the reduction of net reserve purchases from $181.9 billion to −$0.2 billion. There are substantial gains in stability for the terms of trade, exports, and, to a lesser extent, imports. Internally, the inflation rate is more stable, though government spending varies a little more.

Intervention to cause appreciation. When the authorities want to cause an appreciation, the reconstitution regulation again increases the *MSE* and *RMS* for the exchange rate. Net reserve purchases over the course of the run are reduced by the regulation from $56.9 billion to −$1 billion, though the final exchange rate is not much different from that in the unregulated case (see Table 4). Every variable reported in Table 16 except the exchange

TABLE 16

INTERVENTION TO CAUSE APPRECIATION WITH REQUIRED RECONSTITUTION OF RESERVES

(dollar figures in billions)

VARIABILITY			
Variable	*RMS*	*Average Value*	*No. of Changes Exceeding 1% per Month*
Exchange rate (MSE = 0.000005)	0.2460	0.8485	0
Terms of trade	0.0407	1.0613	0
Export orders	0.1967	$10.974	0
Import orders	0.2061	11.313[a]	0
Inflation rate	0.0626	10.0%	0
Government spending	0.2265	$41.048	0

ADJUSTMENT			
	Initial Value	*Equilibrium Value*	*Final Value*
Exchange rate (ratio = 1.087)[b]	0.918	0.849	0.843
Inflation rate	10.2%	10.2%	10.2%

RESERVE PURCHASES	
Longest interval of one-way intervention	15 periods
Average monthly reserve purchase during that interval	−$0.1
Net reserve purchases during the entire run	−$1.0

[a] In billions of ROW currency units.

[b] Adjustment ratio $= \dfrac{\text{initial value} - \text{final value}}{\text{initial value} - \text{equilibrium value}}$.

rate shows increased stability as a result of the reconstitution regulation. This indicates that the nominal exchange rate is bearing more of the burden of adjustment than in the unregulated case.

Intervention to cause depreciation. The reconstitution regulation is highly effective in reducing the ability of national authorities to push the exchange rate away from equilibrium. Table 17 shows that the adjustment ratio is 1.029 in this run, while it was −1.255 in the unregulated run (Table 5). Reserve purchases over the run fall from $348.9 billion to $1 billion. The exchange rate, no longer following the smooth path engineered by unregulated official intervention, is more erratic. Imports show a very small increase in variability. But the terms of trade and exports follow a much smoother path. Domestically, the inflation rate varies substantially less under the reconstitution requirement, while government spending varies just

TABLE 17
INTERVENTION TO CAUSE DEPRECIATION WITH REQUIRED RECONSTITUTION OF RESERVES
(dollar figures in billions)

VARIABILITY			
Variable	*RMS*	*Average Value*	*No. of Changes Exceeding 1% per Month*
Exchange rate (MSE = 0.000004)	0.2455	0.8490	0
Terms of trade	0.0376	1.0608	0
Export orders	0.2006	$10.978	0
Import orders	0.2024	11.310[a]	0
Inflation rate	0.0582	10.0%	0
Government spending	0.2256	$41.049	0

ADJUSTMENT			
	Initial Value	*Equilibrium Value*	*Final Value*
Exchange rate (ratio = 1.029)[b]	0.918	0.849	0.847
Inflation rate	10.2%	10.2%	10.2%

RESERVE PURCHASES	
Longest interval of one-way intervention	16 periods
Average monthly reserve purchase during that interval	$0.06
Net reserve purchases during the entire run	$1.0

[a] In billions of ROW currency units.

[b] Adjustment ratio $= \dfrac{\text{initial value} - \text{final value}}{\text{initial value} - \text{equilibrium value}}$.

a little more. So this run shows dramatically reduced exchange-rate manipulation, resulting in a smoother adjustment to an external shock.

Intervention to lean against the wind. Table 18 shows that when the strategy is to lean against the wind, the reconstitution regulation reduces net reserve purchases from approximately $11.7 billion (see Table 6) to $1 billion, letting the nominal exchange rate vary more with market forces. The final exchange rate is not significantly different with the regulation, however. The terms of trade move more smoothly, with slight reductions in export and import variability. The inflation rate is less erratic, but variability in government spending is increased by a negligible amount.

Summary. The requirement that the authorities reconstitute their reserve position every two years appears to be a good one. This assumes, of course, that the authorities respond prospectively to the regulation, rather

TABLE 18
INTERVENTION TO LEAN AGAINST THE WIND WITH REQUIRED RECONSTITUTION OF RESERVES
(dollar figures in billions)

VARIABILITY			
Variable	*RMS*	*Average Value*	*No. of Changes Exceeding 1% per Month*
Exchange rate (MSE = 0.000004)	0.2451	0.8490	0
Terms of trade	0.0375	1.0610	0
Export orders	0.2005	$10.978	0
Import orders	0.2022	11.310[a]	0
Inflation rate	0.0582	10.0%	0
Government spending	0.2256	$41.049	0
ADJUSTMENT			
	Initial Value	*Equilibrium Value*	*Final Value*
Exchange rate (ratio = 1.029)[b]	0.918	0.849	0.847
Inflation rate	10.2%	10.2%	10.2%
RESERVE PURCHASES			
Longest interval of one-way intervention			10 periods
Average monthly reserve purchase during that interval			$0.1
Net reserve purchases during the entire run			$1.0

[a] In billions of ROW currency units.

[b] Adjustment ratio $= \dfrac{\text{initial value} - \text{final value}}{\text{initial value} - \text{equilibrium value}}$.

than having to engage in reconstitution after exceeding the limit. In each of the four runs, the summary statistics indicate that performance is as good or better than in the corresponding unregulated run. The reconstitution requirement is clearly effective in preventing the currency manipulation that occurs when the authorities want to peg the exchange rate or make it appreciate or depreciate consistently. And it prevents the manipulation without significant negative impact on the stability of variables other than the nominal exchange rate. The nominal exchange rate will generally be more erratic when intervention can no longer keep it on a planned path.

The Reference-Rate Proposal

Finally, the "reference rate proposal" of Ethier and Bloomfield (1975) requires that countries, by common consent, define a reference exchange rate. That reference rate should "constitute, in effect, a statement by the central banks of their collective view regarding the equilibrium structure of exchange rates" (Ethier and Bloomfield, 1975, p. 10). These authors initially suggest periodic negotiation among central bankers as one feasible way to arrive at estimates of the equilibrium exchange-rate structure over time, but later they propose that the IMF be given the task of consulting with members in order to define the equilibrium exchange-rate structure. Once the system is established, the members might choose to use some system of objective indicators to define the reference rate automatically, eliminating the need for an international group to consider the issue.

It is not possible to model the negotiating process proposed by Ethier and Bloomfield as one approach to defining reference rates. It is feasible, however, to include an objective indicator to define a reference rate for each period. The approach I employ is effectively the "crawling reference rate" suggested by Ethier and Bloomfield:

> A weighted average of past market exchange rates could be used to obtain a provisional value of the new reference rate, and this provisional value could then be adjusted upward or downward, as indicated by reserve changes, to obtain the actual value of the new reference rate (Ethier and Bloomfield, 1975, p. 15).

Using the combination of previous exchange rates and reserve changes to arrive at the reference rate reflects recognition that exchange rates in previous periods may have been distorted by national intervention in the market.

Ethier and Bloomfield do not indicate which "past market exchange rates" should be used. I define the reference rate using a six-month moving average of actual exchange rates. Similarly, when Ethier and Bloomfield suggest that the provisional value of the reference rate "be adjusted upward or downward, as indicated by reserve changes" (1975, p. 15), they do not indicate how far upward or downward. The impact of a reserve purchase of x dollars on the exchange rate depends upon the volume of international transactions per period and the elasticities associated with the supply and demand relationships. To approximate the typical effect of a reserve purchase on the exchange rate, I use my model to compare the exchange rate that occurs in period I when there is no intervention with the rate that results when intervention is positive or negative:

$$\frac{1}{x}\left(\frac{\text{exchange rate with reserve purchases equal to } x - \text{exchange rate with no reserve purchases}}{\text{exchange rate with no reserve purchases}}\right)$$

I then average ten such figures to arrive at an estimate of the typical impact of a $1 million reserve change on the exchange rate in a typical period. The estimate is 0.00145 per cent. Therefore, the reference rate for period I is

$$REF\,(\mathrm{I}) = (1.0 - 0.0000145\,A)\left(\frac{1}{6}\right)\sum_{\mathrm{J}=1}^{6} RM\,(\mathrm{I} - \mathrm{J})\,,$$

where REF(I) is the reference rate for period I, RM(I) is the exchange rate for period I, and A is the mean of reserve changes in the preceding six periods.

In addition to establishing a reference rate, the Ethier and Bloomfield proposal imposes upper and lower limits by designating a "certain fixed percentage" above and below the reference rate beyond which reserve purchases and sales are illegal. The authors do not suggest any particular value for the "certain fixed percentage." I set the upper and lower limits at 1.5 per cent above and below the reference rate. Thus, intervention is never required by the reference-rate proposal and is, in fact, outlawed if it pushes the exchange rate more than 1.5 per cent above or below the reference rate.

Intervention to peg the exchange rate. Table 19 shows that when the reference-rate regulation is imposed on authorities seeking to peg their exchange rate, their efforts are partially thwarted. The adjustment ratio for the run changes from zero in the unregulated case (see Table 3) to 0.464 with the reference-rate regulation. The exchange rate moves almost halfway to its new equilibrium following the foreign price disturbance. Net reserve purchases show a corresponding decline; they are about 55 per cent as large

TABLE 19

INTERVENTION TO PEG THE RATE WITH REFERENCE-RATE REGULATION
(dollar figures in billions)

VARIABILITY			
Variable	*RMS*	*Average Value*	*No. of Changes Exceeding 1% per Month*
Exchange rate			
(MSE = 0.000002)	0.1168	0.8882	0
Terms of trade	0.1506	1.0215	0
Export orders	0.2654	$11.546	0
Import orders	0.1876	10.861[a]	0
Inflation rate	0.2296	10.1%	0
Government spending	0.2124	$40.491	0
ADJUSTMENT			
	Initial Value	*Equilibrium Value*	*Final Value*
Exchange rate			
(ratio = 0.464)[b]	0.918	0.849	0.886
Inflation rate	10.2%	10.2%	10.2%
RESERVE PURCHASES			
Longest interval of one-way intervention			105 periods
Average monthly reserve purchase during that interval			$ 0.7
Net reserve purchases during the entire run			$99.7

[a] In billions of ROW currency units.

[b] Adjustment ratio = $\dfrac{\text{initial value} - \text{final value}}{\text{initial value} - \text{equilibrium value}}$.

here as with no regulation. Because the nominal exchange rate bears more of the adjustment burden, it is not surprising that volatility as measured by the *RMS* is reduced for each variable reported, both international and domestic.

Intervention to cause appreciation. Even when the reference-rate regulation is imposed on authorities seeking to cause appreciation, the nominal exchange rate at the end of the run is precisely the same as with no regulation and is not far from the equilibrium value (compare Tables 20 and 4). But the regulation does have some impact. Net reserve purchases decline approximately 9 per cent. The *MSE* and *RMS* for the exchange rate rise slightly, while volatility declines for all other variables reported in Table 20, both international and domestic. This suggests that, as the exchange rate responds more to market forces, real variables bear a smaller adjustment burden.

TABLE 20

INTERVENTION TO CAUSE APPRECIATION WITH REFERENCE-RATE REGULATION
(*dollar figures in billions*)

VARIABILITY			
Variable	*RMS*	*Average Value*	*No. of Changes Exceeding 1% per Month*
Exchange rate (MSE = 0.000002)	0.1493	0.8739	0
Terms of trade	0.1725	1.0365	0
Export orders	0.2414	$11.353	0
Import orders	0.2403	11.013[a]	0
Inflation rate	0.2458	10.2%	0
Government spending	0.2278	$40.626	0

ADJUSTMENT			
	Initial Value	*Equilibrium Value*	*Final Value*
Exchange rate (ratio = 1.149)[b]	0.918	0.849	0.839
Inflation rate	10.2%	10.2%	10.0%

RESERVE PURCHASES	
Longest interval of one-way intervention	78 periods
Average monthly reserve purchase during that interval	$ 0.4
Net reserve purchases during the entire run	$51.8

[a] In billions of ROW currency units.

[b] Adjustment ratio $= \dfrac{\text{initial value} - \text{final value}}{\text{initial value} - \text{equilibrium value}}$.

Intervention to cause depreciation. The reference-rate regulation prevents much of the exchange-rate manipulation that would otherwise occur if the authorities pursued a goal of currency depreciation. This is apparent from the change in the adjustment ratio, which moves from −1.255 in the unregulated run (Table 5) to +0.313 in the reference-rate run (Table 21). No longer does the simulation end with an exchange rate farther from equilibrium than when the simulation began. As one would expect, the reference-rate regulation also reduces the volume of net reserve purchases substantially. The *RMS* for the exchange rate rises, as authorities can no longer attain the desired smooth path toward depreciation, but it is still not as high as in the free-float case. The terms of trade and exports vary less. The *RMS* for imports rises with the reference rate. Domestically, the inflation rate becomes more stable, while government spending fluctuates more.

TABLE 21

INTERVENTION TO CAUSE DEPRECIATION WITH REFERENCE-RATE REGULATION
(*dollar figures in billions*)

VARIABILITY			
Variable	*RMS*	*Average Value*	*No. of Changes Exceeding 1% per Month*
Exchange rate (MSE = 0.000003)	0.1402	0.8993	0
Terms of trade	0.1657	1.0108	0
Export orders	0.2789	$11.713	0
Import orders	0.1825	10.738[a]	0
Inflation rate	0.2443	10.2%	0
Government spending	0.2093	$40.326	0

ADJUSTMENT			
	Initial Value	*Equilibrium Value*	*Final Value*
Exchange rate (ratio = 0.313)[b]	0.918	0.849	0.896
Inflation rate	10.2%	10.2%	10.2%

RESERVE PURCHASES	
Longest interval of one-way intervention	105 periods
Average monthly reserve purchase during that interval	$ 1.0
Net reserve purchases during the entire run	$129.3

[a] In billions of ROW currency units.

[b] $\text{Adjustment ratio} = \dfrac{\text{initial value} - \text{final value}}{\text{initial value} - \text{equilibrium value}}.$

Intervention to lean against the wind. As might have been anticipated, the reference-rate regulation never constitutes a binding constraint in the simulation with authorities intervening to lean against the wind. The intent of the reference-rate proposal is to prevent aggressive intervention. By leaning against the wind, authorities seek to modify trends, not aggravate them. This kind of intervention is therefore always permissible under the reference-rate rule.

Summary. With each of the four intervention strategies, both the domestic and the international economies function at least as well when the reference-rate regulation is imposed as when there is no regulation. In that regard, the regulation is satisfactory. But one might be dissatisfied with the degree of improvement, particularly when the goal of intervention is currency depreciation or a pegged rate. Furthermore, the outcomes I present reflect a definition of the reference rate that keeps it reasonably close to the free-market rate. Since the free-market rate moves fairly smoothly toward the equilibrium rate, so does the reference rate.

If the reference-rate regulation were actually imposed, there is little likelihood that the reference rate for a currency would always be a good estimate of its equilibrium value. If the reference rate varied significantly from a smooth path toward equilibrium, the regulation would permit national authorities so inclined to push their exchange rate in the direction of the "nonequilibrium" reference rate. Similarly, a nonequilibrium reference rate might, on some occasions, limit intervention designed to bring a currency closer to the path toward equilibrium. Although my simulation results show satisfactory performance when the reference rate is defined appropriately, that may well be a simpler matter in the context of a simulation model than in a changing international economy. Therefore, my concern for the proper definition of the reference rate constitutes a significant qualification to my claim that the regulation performs satisfactorily.

6 SUMMARY AND CONCLUSIONS

The model employed in this project yields a free float characterized by reasonably smooth adjustment to the foreign price disturbance that is introduced. An alternative formulation of speculative activity, a different sort of shock, or a change in some other aspect of the model might produce a less satisfactory performance. But with the model as it is described here, the performance of the free float cannot be considered objectionable.

Recognizing, however, that national authorities are likely to intervene occasionally if given the option, I consider the impact of alternative intervention strategies. These simulations lead to several observations, some of which are generally accepted.

First, the results confirm that maintaining an undervalued exchange rate will boost exports and decrease imports. But the boost to exporters and import competitors may come at considerable expense in the form of reserve purchases and a higher inflation rate, even with no change in the rate of growth of the real money stock. In my model, faster real income growth does not exacerbate the rise in inflation, because the growth rate of real income is held constant by fiscal policy.

Second, the results confirm that an undervalued currency can, to some extent, substitute for an expansionary fiscal policy when a country seeks a target growth rate of real income. Average levels of government spending are lower when the authorities intervene to maintain an undervalued currency than in the free float. This is not a surprising result.

Perhaps the most interesting point to emerge from the runs with unregulated intervention is that intervention that smooths nominal exchange-rate change in the aftermath of a disturbance consistently increases the volatility of the real variables reported. (One or two real variables occasionally move more smoothly than under a free float, but it is consistently true that large increases in the volatility of most real variables outweigh small reductions in the volatility of the others.) This reflects the fact that in a free float the nominal exchange rate moves smoothly to accommodate gradual real adjustment. Intervention that prevents exchange-rate adjustment forces adjustment to occur in the real variables. The policymaker thus has a clear choice between adjustment via change in the nominal exchange rate and adjustment via change in real variables. This observation cannot be transposed to mean that all regulations that increase the volatility of real variables will smooth the nominal exchange rate. Rather, it indicates that some exchange-rate change in the face of a shock will assist, rather than prevent, smooth real adjustment. The literature tends to focus on exchange-rate variability as an index of the degree of uncertainty associated with a given exchange-rate regime. Yet the simulation results show that real adjustment costs may, in fact, be lower when exchange-rate variability is higher.

Finally, acknowledging suggestions that a managed float may yield unsatisfactory results unless subject to international regulation, I use my model to compare the performance of alternative regulations proposed in the literature.

To start with the most objectionable, I conclude that the regulation limiting the duration of intervention is entirely unsatisfactory. Unless the authorities modify their intervention pattern before the regulation becomes a binding constraint, the system will be exposed to repeated and substantial disturbances in the form of erratic intervention and erratic consequent exchange-rate changes. In the results reported, the performance of the duration limit is never a significant improvement over the corresponding unregulated case, and it is significantly inferior in three of the four runs. I conclude that an unregulated managed-float system would be preferable to a system regulated in this manner.

About the best that can be said for the reference-rate proposal is that its performance in each run is at least as good as no regulation. As I formulate it, the reference-rate proposal could be criticized as being too weak, allowing too much currency manipulation. But the most serious flaw is the difficulty of continuously defining reasonable reference rates.

I modeled the requirement that reserves be periodically reconstituted on the assumption that the authorities will modify their intervention pattern before the regulation becomes binding. So long as this is the case, my simulation results support a reconstitution regulation. It improves over the unregulated runs by substantially reducing currency manipulation, and real variables show smoother adjustment to the foreign price disturbance. Of course, if the authorities intervened without regard for the potential consequences of the reconstitution regulation, it would prove much less satisfactory and result in significant exchange-rate volatility.

Finally, a ceiling on the volume of reserve purchases or sales per period performs admirably in the context of the model. It is very effective in limiting exchange-rate manipulation while simultaneously reducing the magnitude and abruptness of variation in real variables. If a reasonable ceiling on intervention were put into practice in today's international financial system, I would expect it to function quite satisfactorily.

APPENDIX

(all variables expressed in billions of current dollars unless otherwise noted)

- *A* = mean change in international reserve holdings over the six preceding periods
- *AR* = speculator's point estimate of the exchange rate for the next period (in dollars per unit of foreign currency)
- *C* = desired ratio of currency to demand deposits ($C = 0.292$)
- *CA* = volume of short-term interest-sensitive capital flows into US
- *CON* = constant term in the market-clearing conditions for the foreign-exchange market
- *CSH* = number of dollars purchased by speculators during the period
- *DEP* = dollar value of capital-stock depreciation
- *DMP* = dollar value of import payments
- *DW* = change in real wealth between period (I - 1) and period (I) (in billions of 1970 dollars)
- *DYP* = real permanent disposable income (in billions of 1970 dollars)
- *F* = capital inflow resulting when the differential between US and ROW interest rates rises from $z\%$ to $(z + 1)\%$ ($F = 0.78$ billion current dollars)
- *G* = US growth rate of labor productivity ($G = 1.8\%$ per year)
- *GB* = number of bonds (consols) sold in open-market operations at a price of $1/R$ each (in billions)
- *GS* = nominal government spending
- *LR* = legally required reserve ratio on demand deposits in the banking system ($LR = 0.177$)
- *MAV* = twelve-month moving average of the exchange rate (in dollars per unit of foreign exchange)
- *MAX* = amount of intervention permitted before a country exceeds a limit set by regulation
- *MD* = nominal value of *RMD*
- *MM* = money multiplier [$MM = (C + 1)/(LR + C + X)$]
- *MO* = import orders placed in the current period by US from ROW (quantities measured in units worth 1 billion of foreign-currency in 1970)
- *MP* = foreign-currency value of import payments (in billions of foreign-currency units)
- *MS* = nominal money stock in US
- *MSE* = mean squared error of exchange rates from their twelve-month moving average
- *NEX* = level of real net exports in US (in billions of 1970 dollars)

NF = US monthly inflation rate (in %)
NFF = ROW monthly inflation rate (in %)
P = US price index
PF = ROW price index
PM = average rate of change of imported-goods prices over preceding twelve months (in %)
Q = stock-adjustment coefficient
R = nominal US short-term interest rate (in %)
RC = real value of US consumer spending (in billions of 1970 dollars)
RCA = real value of short-term capital flows into US (in billions of 1970 dollars)
REF = reference exchange rate (in dollars per unit of foreign currency)
RES = nominal dollar value of international reserves held by US monetary authorities
RF = nominal ROW short-term interest rate (in %)
RI = real investment in US (in billions of 1970 dollars)
RK = real value of capital stock (in billions of 1970 dollars)
RM = spot exchange rate (in dollars per unit of foreign currency)
RMD = demand for real money balances for purposes other than exchange-rate speculation (in billions of 1970 dollars)
RMS = root mean square of successive differences in the specified variable over the course of the run (in %)
RRM = root mean square of successive differences in the exchange rate over the course of the run (in %)
RSC = dollar value of US purchases (+) or sales (−) of international reserves
RY = US real income (in billions of 1970 dollars)
RYF = ROW real income (in billions of 1970 dollars)
RYP = potential real output (in billions of 1970 dollars)
S = scalar relating exchange-rate speculators' desired currency positions to their profit expectations
SFD = speculators' desired short position in foreign currency (in billions of current units of foreign currency)
SH = speculators' actual long position in dollars at end of the current period
SHD = speculators' desired long position in dollars
SQ = depreciation rate ($SQ = 0.00417$ per month)
TAX = nominal dollar value of all taxes each period (tax revenues in real terms grow at a constant 1.8% annual rate)
TT = terms of trade between US and ROW
U = unemployment rate (in %)
W = real wealth in the private sector (in billions of 1970 dollars)

X = desired ratio of excess reserves to demand deposits of the commercial banking system ($X = 0.0015$ in accord with available data)

XO = real dollar value of ROW orders for US goods placed in the current period (quantities measured in units worth 1 billion 1970 dollars)

XP = dollar value of export payments

XPR = dollar value of all goods and services produced in the current period for sale as exports (XPR is a weighted average of previous export orders)

Y = nominal income in US

REFERENCES

Branson, William H., "Monetary Policy and the New View of Capital Movements," *Brookings Papers on Economic Activity*, Vol. 2, 1970, pp. 2-262.

Branson, William H., and Thomas D. Willett, "Policy toward Short-Term Capital Movements: Some Implications of the Portfolio Approach," in F. Machlup, W. Salant, and L. Tarshis, eds., *International Mobility and Movement of Capital*, New York, National Bureau of Economic Research and Columbia University Press, 1972, pp. 287-310.

Bryant, Ralph C., "Empirical Research on Financial Capital Flows," in Peter B. Kenen, ed., *International Trade and Finance: Frontiers for Research*, Cambridge, England, Cambridge University Press, 1975.

Ethier, Wilfred, and Arthur I. Bloomfield, *Managing the Managed Float*, Princeton Essays in International Finance No. 112, Princeton, N.J., Princeton University, International Finance Section, 1975.

———, "The Reference Rate Proposal and Recent Experience," *Banca Nazionale del Lavoro Quarterly Review*, 126 (September 1978), pp. 211-232.

Goldfeld, Stephen M., "The Demand for Money Revisited," *Brookings Papers on Economic Activity* (3, 1973), pp. 577-638.

Kenen, Peter B., "Floats, Glides and Indicators: A Comparison of Methods for Changing Exchange Rates," *Journal of International Economics*, 5 (May 1975), pp. 107-151.

Mikesell, Raymond F., and Henry N. Goldstein, *Rules for a Floating-Rate Regime*, Essays in International Finance No. 109, Princeton, N.J., Princeton University, International Finance Section, 1975.

Miller, Norman, and Marina V. N. Whitman, "The Outflow of Short-Term Funds from the United States: Adjustments of Stocks and Flows," in F. Machlup, W. Salant, and L. Tarshis, eds., *International Mobility and Movement of Capital*, New York, National Bureau of Economic Research and Columbia University Press, 1972, pp. 253-286.

Okun, Arthur M., *The Political Economy of Prosperity*, Washington, D.C., The Brookings Institution, 1970.

Willett, Thomas D., and Francesco Forte, "Interest Rate Policy and External Balance," *Quarterly Journal of Economics*, 83 (May 1969), pp. 1063-1080.

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