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6 The Use of Monetary Policy for Internal and External Balance in Ten Industrial Countries

Stanley W. Black

6.1 Introduction and Methodology

The 1970s have seen not only a deterioration in the average macroeconomic performance of the industrialized countries but also increased dispersion about that average. For example, as the unweighted average inflation rate of a group of ten leading industrialized countries rose from 4.0 percent during 1963–70 to 8.9 percent during 1971–79, the dispersion of inflation rates as measured by the unweighted standard deviation rose from 0.8 percent to 2.5 percent. Similarly, as the unweighted average unemployment rate among eight of the same countries rose from 2.7 percent during 1964–70 to 4.3 percent during 1971–79, its dispersion rose from 1.5 percent to 1.9 percent.[1]

While the increased dispersion of inflation rates has clearly led to and been associated with increased flexibility in exchange rates, it also appears to have led, at least in part, to the increased levels and dispersion of unemployment rates, as high-inflation countries have often been forced to adopt restrictive macroeconomic policies.

The various factors contributing to the increased dispersion in macroeconomic performance can be divided into differences in internal and external economic *shocks* hitting different countries, differences in the economic *structures* of different countries, such as openness, degree of indexation of wages, dependence on oil imports, etc., and differences in

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1. Inflation and unemployment rates on standardized definitions from OECD *Economic Outlook* 28 (December 1980):135–36.

monetary and fiscal *policies*, as well as other policies followed by the countries in question.

Other authors have concentrated their efforts on differences in economic structures, and it is clear that these have a major role in explaining both differences in responses to external factors, such as the oil price increases of 1974 or 1979–80, and differences in the effectiveness of different types of economic policies (Argy and Spitaeller 1980; Sachs 1979). The main hypothesis underlying this paper is that even if disturbances and economic structures were constant across countries, differences in the *utilization* of economic policies would lead to differences in performance.

Now it is quite clear that there is a relationship between the effectiveness of policies, which depends on economic structure, and their utilization. Ineffective policies should be little utilized, one suspects. Thus cross-country comparisons of the utilization of policies should be related to differences in economic structure. In future work such comparisons will be undertaken.

The purpose of this paper is to seek to quantify systematically differences in the utilization of monetary policy instruments among ten leading industrialized countries (Belgium, Canada, France, Germany, Italy, Japan, the Netherlands, Sweden, the United Kingdom, and the United States). Past cross-country studies of this nature have used graphical, tabular, and verbal chronologies of monetary policy instruments and targets over some given time period (Michaely 1971; Thygesen and Shigehara 1975; Black 1977). The technique, while highly useful, suffers an inevitable lack of precision. While there are numerous econometric studies of individual country monetary policy reaction functions, a systematic cross-country study seems to have not been done.

The methodology of the study is in principle straightforward but involves some econometric complications. It is assumed in section 6.2 that the monetary authorities behave as if they maximize an intertemporal welfare function subject to an implicit perceived econometric model of the private economy. The process is assumed to yield a set of policy reaction functions relating the policy instruments directly under the authorities' control, such as the discount rate, reserve requirements, open market operations, and lending to commercial banks, to a set of internal and external target variables, such as inflation, unemployment, and the balance of payments and/or the exchange rate.

Despite the frequent use by economists of market-determined variables, such as the rate of growth of the money supply or short-term interest rates, as "instruments" of central banks, I believe that the term should be limited to variables which are actually in the hands of the authorities. There is an extensive literature on the use of "intermediate" targets, such as the money supply or short-term interest rates, as a means of influencing the ultimate targets (for a recent discussion, see Bryant 1980). Since these intermediate targets have little or no welfare significance in and of themselves, they cannot be used in the welfare function to represent the factors motivating policy choices.

On the other hand, they might be used as measures of the policy intentions of the authorities, that is, as instruments. Unfortunately, both market interest rates and money supplies are jointly determined by policy and the markets. Therefore, at most they can be regarded as intermediate targets in a two-stage strategy of monetary control (Bryant, 1980, chap. 15). The complexities of successfully modeling such two-stage strategies for several different countries does not recommend itself to this researcher. In any event, the intermediate target is in actuality only a veil between the actual levers of policy and the ultimate targets. While it is true, as Bryant has argued, that the intermediate target may be pursued myopically and therefore take on an independent life of its own (as target or instrument?), it seems simpler to treat such behavior as a shift in the use of the actual instruments. Thus, one can add the monetary growth target to the independent variables in the reaction function to see if it has independent effects.

Within a reaction function framework, one must allow for lags in the adjustment of various instruments that are adjusted only discretely, such as discount rates, credit controls, and reserve requirements. A threshold regression technique is developed in appendix A and is used to capture this phenomenon which appears to be rather widespread.

A further complication is that standardized reaction functions are being applied to a widely differing set of monetary policy instruments in each country. Given a decision to use the actual instruments under the control of the authorities, the researcher must then study the institutional characteristics of the monetary system in each country (Hodgman 1974; Holbik 1973). It would be desirable to define instruments as uniformly as possible for purposes of cross-country comparisons. Discount rates are reasonably uniform, but other instruments, such as credit controls, reserve requirements, discount quotas, and open market operations, differ substantially across countries. Perhaps the best approach might be to convert such measures into their equivalent effect on the reserve base, but even that is not possible for credit controls.

Changes in the operating techniques of monetary policy clearly must be incorporated into the analysis, either by combining instruments that are used alternatively at different times or else by dummy variables of some type. A more general version of this issue arises in the context of the assignment problem discussed below. It is possible to argue that multiple monetary instruments are unnecessary and that estimates of these coefficients would be unstable. However, if the authorities are uncertain about the economic structure, it is likely that they would prefer to use a variety of instruments jointly rather than rely on only one.

In one sense, reaction functions are bound to be unstable, since we know they change with changes in policy preferences (welfare functions) and with changes in economic structure (pegged versus floating rates, etc.). The study of this instability is, in fact, one of the reasons for examining reaction functions.

Taking shifts in political power into account is an essential part of estimating policy reaction functions. However, the researcher must avoid the appearance of ex post justification of large residuals by convenient dummy variables. Therefore, the proper approach is to go through a source (such as *Keesing's Contemporary Archives*) systematically and note down all potentially significant political changes, keeping the number relatively small.

Several types of dummy variable techniques may be used to test for the effects of shifts in political power. A simple additive dummy tests for changes in the "target" values of the variables entering the welfare function. Dummy variables on the slope coefficients of the reaction functions test for shifts in the relative weights in the welfare function, as well as for possible differences in the underlying perceived model of the economy. Most generally, split samples can be used to test for differences in the entire policy reaction function, if enough data are available on each political regime. The latter two tests may be regarded as measuring the "interaction" effects of political and economic variables on economic policy behavior. Appendix B briefly summarizes the relevant instruments in each country and takes note of shifts in the use of such instruments over time. Finally, shifts in political power can lead to shifts both in welfare functions and in the economic environment faced by decisionmakers. These factors, too, are discussed where relevant in appendix B.

The results of the study, in the form of a series of reaction functions for each country, are presented and discussed in section 6.4 of the paper. Conclusions are suggested in section 6.5.

6.2 A Model of Central Bank Behavior

While there is little reason to believe that central banks actually use formal optimization techniques except for illustrative studies, the usual "as if" assumption will justify modeling their behavior as the solution of an optimal control problem with a multiperiod welfare criterion (Chow 1975). I would emphasize that it is not necessary to believe that the policymakers actually use these tools. In particular, it is not necessary to believe that the actual policies chosen are optimal, unless one wants to solve the "inverse" problem and estimate the parameters of the welfare function as explained by Chow (1981, chap. 16) and Friedlaender (1972). This argument rests on the use of theory as an approximation to reality and becomes suspect only when the underlying theory is inadequate to describe the phenomena in question.

The Lucas critique (1976) of econometric policymaking and the "new classical macroeconomics" of the rational expectations school might lead one to doubt the adequacy of the macroeconomic theory underlying central bank policy reaction functions. If, for example, it is true that monetary policy has no systematic effect on the real variables of the economy, then a theory of monetary policy which assumes the contrary may seriously mislead the policymakers. On the other hand, it appears that tests with recent macroeconomic data are unable to distinguish between the "new classical" hypotheses and the neo-Keynesian hypotheses embodied in most central bank econometric models (Sargent 1976). Under these circumstances, it seems unlikely that reaction functions which hypothesize a Keynesian world will be seriously in error *as descriptions of behavior.*

Specification of the targets entering the welfare function is on the surface quite simple. Inflation, unemployment, and the balance of payments are enshrined as goals in both textbook and central bank guidelines. Unfortunately, there are several problems in making these targets explicit. First, do only current inflation and unemployment matter? Because of the well-known tendency of output to respond in the short run and inflation only later, it is obviously necessary to adopt an intertemporal welfare function which takes account of the delayed effects of policy. Second, why should the balance of payments enter at all? And what measure of the balance of payments? I argue that the level of foreign reserves should enter to account for the increasing cost of borrowing as the net borrowed position rises. However, if foreign ownership of domestic assets is a significant "noneconomic" issue, the current account may enter as a separate external target affecting welfare, as I seem to have found in the case of Japan and France.

The instantaneous or one-period welfare function that enters into the multiperiod criterion is thus assumed to depend negatively on the rate of change of the consumer price index ($\hat{p}$), the deviation of the unemployment rate from a long-run target ($u - \bar{u}$), and the deviation of end-of-period international reserves from a long-run target level ($f - \bar{f}$).

$$W_t = W_t(\hat{p}_t, u_t - \bar{u}, f_t - \bar{f}). \tag{1}$$

These objectives, while not exhaustive, encompass the major policy targets. Real income and consumption, the truly ultimate targets, may be thought of as being affected by all three of the arguments of (1), as well as by the capital stock.

The constraints facing the authorities can be described as follows:

Consumer prices depend on the price levels of domestic and imported goods, allowing for the exchange rate. The demand for domestic output depends through an IS curve on the savings rate and the propensity to import, exports, government spending, tax policy, and the expected real rate of interest. The supply of domestic output is related to potential output and the unemployment gap $(u - \bar{u})$ via Okun's law. An expectations-augmented Phillips curve relates the rate of change of wages to the unemployment gap, expected inflation, current inflation, and past inflation, through indexation and "catch-up" bargaining. Domestic prices depend on wages adjusted for productivity (unit labor costs) plus changes in the cost of imported inputs.[2]

The monetary side of the policymakers model has both stock and flow dimensions. At the beginning of any time period, given stocks of high-powered money and domestic and foreign bonds are available to domestic and foreign residents. The quantities of these stocks may, however, be altered within the period by monetary, fiscal, and exchange market intervention decisions the authorities make. Individuals' portfolio demands to hold different types of assets are assumed to depend on wealth, income, exports and imports (through trade financing), domestic and foreign interest rates, and the current and expected future price of foreign exchange. Interest rates and exchange rates will move to equilibrate these markets, taking into account central bank actions which influence the monetary base and the supply of net foreign assets.

Over time, flows in the government budget and in the current account of the balance of payments will change the supplies of domestic and net foreign assets available to domestic and foreign wealthholders.[3] The current account itself is assumed to depend on domestic and foreign income levels, net interest earnings on foreign assets, and a distributed lag on the ratio of domestic to foreign prices, corrected for the exchange rate (p/ep^*).

Maximization of the intertemporal welfare function subject to the constraints of the model described above, including uncertainty about its structure and coefficients, can be expected to yield policy reaction func-

2. A reduced form of such a supply side can be shown to relate the output gap to actual and expected rates of inflation and changes in the terms of trade. Given (i) $q_t - \bar{q} = \epsilon (u_t - \bar{u})$; (ii) $\bar{w}_t = \psi \; (u_t - \bar{u}) + \phi \; (\alpha E \; \hat{p}_{t+1} + \beta \hat{p}_t + \gamma \hat{p}_{t-1})$, $\alpha + \beta + \gamma = 1$; (iii) $\hat{p}_t = \mu \hat{p}^f_t + (1 - \mu)\hat{p}^d_t$; (iv) $\hat{p}^d_t = \hat{w}_t - \pi + \lambda \hat{p}^f_t$, we find (v) $q_t - \bar{q} = \epsilon\psi^{-1} \{\pi + [1 - \phi(1 - \mu)]\hat{p}^d_t - (\lambda + \phi\mu)\hat{p}^f_t - \phi[\alpha(E\,\hat{p}_{t+1} - \hat{p}_t) - \gamma(\hat{p}_t - \hat{p}_{t-1})]\}$.

3. See Black (1977, appendix) or Branson (1979) for details. Consider the following simplified version, where foreigners do not hold domestic bonds. Let $h = d + ef$ be the high-powered monetary base, with domestic and foreign components. Let $a = b + ek$ be private bondholdings, with domestic and foreign components. Then we assume (i) $h/p = h(r, y)$; (ii) $b/a = b(r, r^*, E\hat{e}, py/a)$; (iii) $ek/a = k(r, r^*, E\hat{e}, py/a)$ for stock equilibrium. Given the current account in terms of foreign currency, (iv) $c = c(y, y^*, (p/ep^*)_{-i}, r, r^*$ $k_{-1})$, the balance of payments implies $\Delta f + \Delta k = c$. The government budget deficit is financed through issuance of domestic bonds and high-powered money, equal to $\Delta b + \Delta d$.

tions for monetary and fiscal policy as well as exchange rate intervention policy. In general, these policy reaction functions will depend on currently observed values of the endogenous variables of the model, and possibly some of the exogenous variables, which may provide information on the state of the economy and hence on future movements of the variables entering the welfare function.

In particular, I assume that the monetary policy reaction functions will depend on currently observed inflation ($\hat{p}$), unemployment (u), and output gap; the ratio of reserves to imports (f/m); the ratio of exports to imports as a proxy for the current account (x/m); the ratio of domestic to foreign prices corrected for exchange rates (p/ep^*); and the foreign interest rate (r^*). There is, of course, a whole set of monetary policy instruments to be considered, including the discount rate, reserve ratios, credit controls, discount quotas, and open market operations to change the monetary base. Increases in the first three of these instruments and decreases in the latter two would be contradictionary.

The reaction function for the discount rate is expected to have the following signs, with similar signs for reserve requirements and credit controls, opposite for the other instruments.

$$rd = F(\overset{+}{\hat{p}}, \overset{-}{u}, \overset{-}{\text{gap}}, \overset{-}{f/m}, \overset{-}{x/m}, \overset{\pm}{p/ep^*}, \overset{+}{r^*}) \tag{2}$$

Obviously, higher inflation, lower unemployment, and a lower output gap would all be expected to lead to tighter money, ceteris paribus, as would a low level of international reserves. A current account deficit, or low value of exports relative to imports, would lead to tighter money if the authorities want to encourage foreign borrowing to finance the deficit or if they simply adopt an expenditure-reducing policy for external reasons. A high value of domestic relative to foreign prices (p/ep^*) will lead to tighter money if the authorities try to reduce inflation to improve competitiveness. On the other hand, if they decide to let the exchange rate depreciate, it would lead to easier money. Finally, a higher interest rate abroad would lead to tighter money to avoid capital outflow and either exchange rate depreciation or loss of reserves.

In the case of reserve ratios, discount quotas, and open market operations, however, the signs on the external variables f/m and x/m may be reversed if sterilization of reserve flows or capital flows is an important objective. Such behavior would indicate predominance of the internal over the external policy targets.

Uncertainty about the parameters of the economic structure is enough to assure that no surplus of redundant policy instruments is waiting about to be assigned in different packages to achieve given targets (Chow 1975, chap. 10). Nevertheless, the Mundellian literature on assignment suggests two main issues. First, different combinations of instruments will be utilized according to which particular target variable is farthest from its optimum value. This aspect of the assignment problem is already captured in separate reaction functions for different instruments which depend on a group of target variables, presumably with different coefficients.

Second, it is possible that the assignment "rule" will change with changing perceptions about either the economic structure or the weights of different targets in the welfare function. This problem is most obvious in the switch from pegged to floating exchange rates, but it is in fact more general. The correct response is to allow for shifts in the reaction functions by means of split samples or dummy variables.

6.3 Econometric Issues

There are several econometric issues to be considered in the estimation of equations such as (2), particularly relating to data frequency, observation lags, thresholds for decisions, expectations, and simultaneity. While quarterly data may be good enough for some purposes, I believe there are several good grounds for preferring monthly data. Since the reaction functions are expected to shift fairly often, degrees of freedom are in short supply and should be maximized by use of monthly data. Second, the timing of policy changes is more accurately dated and related to changes in economic conditions in the monthly data. Third, the basic decision process in central banks is related to the release of important economic data, many of which appear on a monthly basis. Obviously, intramonthly changes in policy are made, and in many cases no changes are made for several months in a row, so the month is simply a compromise based on considerations of data and the decision process. Other choices are possible.

The standard, discrete-time optimal control literature (Chow 1975) bases current period decisions on previous period values of the dependent variables. For most of the data in question, simple reporting lags suggest that this is appropriate. Lengthier distributed lags can be tested as an empirical issue. On the other hand, certain variables, such as foreign interest rates and reserve holdings, are observed by central banks contemporaneously, simply from the markets and their own balance sheets. This suggests that the continuous time model (Chow 1981, chap. 17) in which the policy reaction depends on the current observed value is more appropriate for such variables. However, end-of-period reserve holdings do not appear to be the appropriate variable to which current period policy responds, so in this case I use beginning-of-period reserve holdings.

Furthermore, several of the monetary policy instruments are adjusted only discretely at intervals of differing length, in particular the discount rate, reserve ratios, credit controls, and discount quotas. For the nine countries with monthly data available, the discount rate was changed in only 19 percent of the months observed. The reasons for such infrequent adjustments presumably lie in political and administrative costs of making more frequent changes.

Under these circumstances, ordinary least-squares regressions will show highly autocorrelated residuals, as the predicted value will tend to lie above or below the actual value of the dependent variable by increasing amounts prior to a change. Adoption of a Koyck lag or a Cochrane-Orcutt correction for autocorrelation will erroneously place most or all of the explanatory power on the lagged dependent variable or the lagged residual (Theil 1971).

The appropriate statistical model for this situation appears to be *threshold* regression, in which the dependent variable adjusts to equal the value of the regression function only if the implied change exceeds an estimated threshold value. A nonlinear maximum likelihood approach to this problem has been described by Dagenais (1969, 1975). Appendix A shows that if one is willing to assume that the dependent and independent variables entering the regression equation come from a covariance stationary stochastic process with normally distributed innovations, then it is possible to calculate consistent estimates of the regression coefficients by means of a simple correction to the ordinary least-squares estimates.

The intuition behind the correction can be explained if one considers the *desired* change in the dependent variable, from (2) say $z^* = rd^* - rd_{-1}$, as a normally distributed random variable with mean μ and variance σ^2. Then the *observed* change z will be equal to zero unless $z^* \geqq k$ or $z^* \leqq -k$, where k is the threshold, in which cases it is equal to z^*. If we standardize to $(z^* - \mu)/\sigma$, there is a central region of the standard normal distribution whose area corresponds to the percentage of "no change" cases, an upper tail whose area corresponds to the percentage P_1 of "increases," and a lower tail corresponding to the percentage P_2 of "decreases." (See Figure 6.A.1 in Appendix A.) The abscissas of the boundaries of these areas are easily shown to be $-(k + \mu)/\sigma$ and $(k - \mu)/\sigma$, which can be estimated from the sample proportions P_1 and P_2.

It can be shown that the variance of the observed changes, z, is a downward-based estimate of the variance of the desired changes, with a bias factor approximately equal to $B = P_1 + P_2 + (k/\sigma)(f_1 + f_2)$, where f_1 and f_2 are the ordinates of the standard normal distribution corresponding to the abscissas of the boundary points noted above. Similarly, it can be shown that the ordinary least-squares regression coefficients are biased downward by a factor exactly equal to B. This correction factor is applied to the coefficients of the stochastic explanatory variables entering

(2) in the threshold regressions reported below, and also to the nonstochastic dummy variables representing changes in the political or economic environment or shifts in the use of instruments.

In a few cases where credit controls have been utilized and there is no effective measure of the relative strength of the controls, their use can only be indicated by a simple zero-one dummy variable. In such cases a logit regression model has been adopted, in which it is assumed that the logarithm of the odds, $p/(1-p)$, in favor of the use of controls is a linear function depending on the same variables as in (2) (Theil 1971, pp. 632ff.; Cox 1970).

Several issues with respect to expectations of future values of targets and instruments have been discussed in the literature. When the economic structure includes expectations of future values of economic variables, the rational expectations hypothesis implies that the current equilibrium depends on the expected future path of economic policy variables (Chow 1981, chap. 15). How does this issue affect the reaction functions if the rational expectations hypothesis is relevant?

Kydland and Prescott (1977) show that the optimal open-loop control policy is inconsistent (i.e., different from the policy derived by backward optimization and expressed as a closed-loop reaction function). The traditional example is the final exam. The optimal examination policy is to announce a final exam at the beginning of a course and hold it on schedule. Backward optimization on the day of the final exam leads to cancellation of the final, as the students have already learned the material. Fischer (1980) shows that this problem arises from the use of noncooperative equilibria in a multiple-player game setting. The basic conclusion is that policy behavior based on feedback rules may be suboptimal. However, this does not appear to invalidate the use of a policy reaction function as a description of normal policy behavior, as long as the authorities are allowed to change their behavior every once in a while to deal with extraordinary situations (central banks in the crisis zone).

The second issue is whether the expectations of future values of the target variables should appear in the reaction functions themselves? This question has been discussed by Chow (1981, chap. 15.3), who agrees that these expectations might indeed appear in the reaction functions, but then argues that the expectations can be expressed as functions of currently observed (i.e., lagged) values of the target variables. In that case, the lagged values already incorporate all currently available information about the expected future values of the target variables.

The final econometric problem to be considered is the possibility of simultaneity between the instruments of monetary policy and the targets at which they are directed. While the reaction functions relate the instruments to the targets, for example, $rd = f(u)$, the equations of the economic structure show that the targets are related to the instruments, as $u = g(rd)$. However, the use of lagged values of the target variables has the effect of removing such simultaneity, unless there is a serious problem of autocorrelated residuals. Furthermore, the structural models all confirm that there are long lags in the effects of monetary policy instruments on the main targets, such as inflation, unemployment, and the current account of the balance of payments. Use of the beginning-of-period level of reserves helps to avoid simultaneity there as well.

The one area in which simultaneity is unavoidable is in estimation of the sterilization coefficient, by which the monetary impact of current changes in international reserves is offset by open market operations. In this case, a two-stage least-squares approach seems appropriate.

6.4 Results

The results of estimating monetary policy reaction functions for the ten countries are presented in table 6.A.1 (appendix C). Exact definitions of the variables referred to above and their sources are given in appendix D. The overall results may be described as reasonably successful. Of 177 coefficients, excluding the time trend and dummy variables, 93 appear to be significant with the expected sign, while only 16 appear to have significantly wrong signs. Significance levels are frequently quite high. There are a few troublesome results, which will be discussed below, particularly for the U.S. unborrowed reserves equation. The basic general conclusion, however, is that all of the measured instruments of monetary policy do respond significantly in predictable ways to customary measures of internal and external imbalance.

Of course the main interest in a study like this is in cross-country comparisons. Such comparisons are most readily made in the context of the discount rate equations, which are reasonably homogenous across countries. Therefore, table 6.1 presents consistent coefficient estimates for the main internal and external variables in the discount rate equation. Thus the ordinary least-squares coefficients from table 6.A.1 (appendix C) have been corrected by division for the bias factor B (discussed in section 6.3 and shown in table 6.A.1 in parenthesis together with the sample proportion $P = P_1 + P_2$). In addition, the coefficient estimates for Italy have been adjusted to account for the fact that the discount rate was not used as an instrument of monetary policy until July 1969, or for 35 percent of the typical sample period 1964–79. There is also an inevitable ambiguity about the relative size of the unemployment coefficients for France, Japan, and the Netherlands, since the ratio of unemployed persons to vacancies was used in those equations rather than the unemployment rate. While there is always some lack of comparability across countries for the other variables, their definitions are close enough to

Table 6.1 Consistent Coefficients for Discount Rate Equations

Coefficient and Rank	BG	CN	FR	GR	IT[a]	JP	NL	SW	UK	US
Internal variables										
$\hat{p}$	1.21	−0.08	0.87	1.14	0.95	0.41	0.02	0.42	−0.22	0.79
	1	9	4	2	3	7	8	6	10	5
u	−0.43	−0.39	−0.38[b]	−0.38	−1.17	−1.18[b,c]	−0.41[b]	−1.32	−0.05	−0.76
	5	5	5?	5	2	2?	5?	1	10	4
Average rank	3.0	7.0	4.5	3.5	2.5	4.5	6.5	3.5	10.0	4.5
External variables										
f/m	−0.81	−1.69	−0.79	0.06	−0.31	−0.68	0.59	−1.92	−4.92	−0.34
	4	3	5	9	8	6	10	2	1	7
x/m	−1.85	1.52	−6.77	−0.14[d]	−0.85	−7.04	−1.63	0.08	−10.06	0.86
	4	10	3	7	6	2	5	8	1	9
p/ep^*	0.01	0.01	−1.74	0.05	−0.45	−7.32	0.11	0.03	0.08	−0.06
	5	5	9	3	8	10	1	4	2	7
r^*	0.36	—	0.28	0.67	−0.25	0.16	0.42	0.06	0.31	—
	3	8	5	1	10	6	2	7	4	9
Average rank	4.0	6.5	5.5	5.0	7.75	6.0	4.5	5.25	2.0	8.0

[a]Estimated coefficient times 0.65 = 124/190 to allow for nonuse in 1963–69.
[b]Not comparable as u = # unemployed/# vacancies.
[c]Estimated coefficient times 0.1 based on regression of # unemployed/# vacancies on unemployment rate.
[d]Independent variable is dnfa.

allow one to argue that changes in such variables represent the same phenomena in each country.

From table 6.1, relatively high weights are given to the inflation target by Belgium, Germany, Italy, France, and the United States, while relatively lower weights are given to inflation by Britain, Canada, the Netherlands, Japan, and Sweden.[4] These, of course, are average responses over the sample period 1963–79. In figure 6.1, we observe that the weight given to the inflation rate is inversely correlated with the observed average inflation rate over the inflationary period 1971–79, with the exceptions of Italy, the Netherlands, and Canada.

This evidence appears to support the proposition that countries which give a relatively high policy weight to inflation succeed in having lower inflation rates, at least in most cases. A cross-section regression equation of average inflation ($\hat{p}$) on the inflation coefficient ($\beta\hat{p}$), net oil imports in 1973 as a percent of total primary energy consumption (OIL), and external orientation to a large stable trading partner (EXT) yields

$$\underset{}{\hat{p}} = \underset{(4.0)}{9.83} - \underset{(2.2)}{4.27}\beta\hat{p} + \underset{(2.5)}{6.44}\ \text{OIL} - \underset{(1.0)}{0.51}\ \text{EXT}, \qquad R^2 = .57,$$

where EXT is equal to the external rank from table 6.1 × largest MERM weight × standard deviation of inflation rate of largest MERM-weight partner. This equation is plotted as a line in figure 6.1. During the 1970s, Canada and the Netherlands succeeded in having relatively low inflation despite having low policy weights for domestic inflation, while Italy did not succeed despite having a high weight. In the cases of Canada and the Netherlands, energy self-sufficiency and orientation to a large, stable trading partner contributed to this result, while Italy lacked these saving graces.

The unemployment coefficients tend to cluster around the value 0.4, with four countries apparently significantly above that value (Japan, Sweden, Italy, and the United States) and one country well below (the United Kingdom). Since Italy and the United States are counries with high average unemployment rates and Japan, Sweden, and the United Kingdom with low, there is little correlation between the observed unemployment rates and the policy weights given to the unemployment target. Presumably this reflects the substantial structural component in cross-country differences in unemployment rates, or the assignment of fiscal policy to unemployment.

Figure 6.2 shows the relationship between weights for the inflation and unemployment targets. After taking account of oil dependence and external orientation, there is a clear inverse correlation between the weights assigned to the two targets. A cross-section regression of the inflation

4. These are weights in the *reaction functions* (2) and are not to be misinterpreted as weights in the *welfare function* (1).

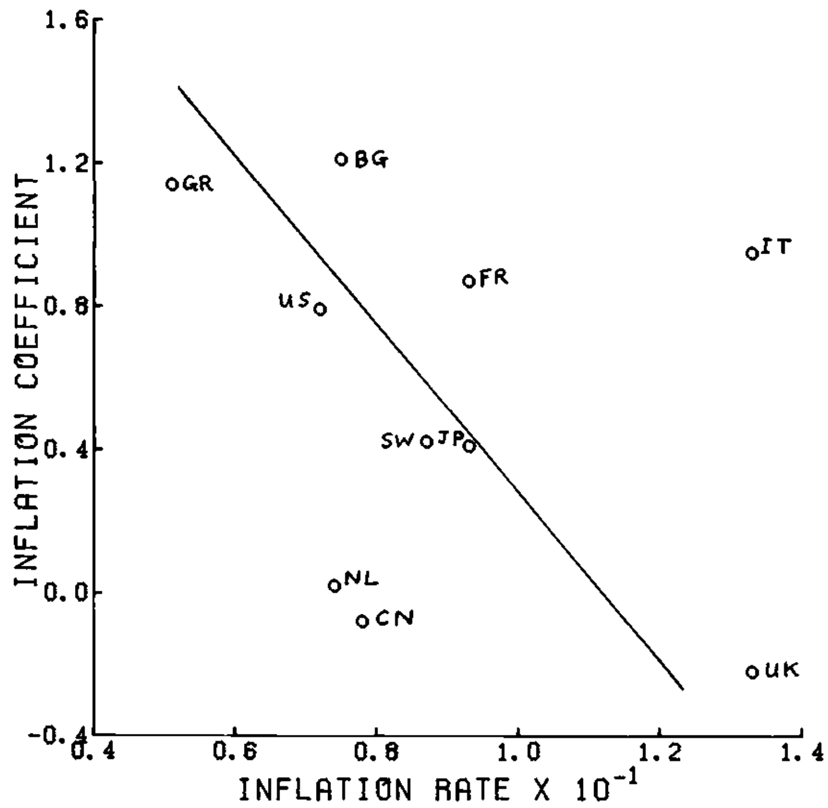

Fig. 6.1

coefficient ($\beta\hat{p}$) on the absolute value of the unemployment coefficient (βu), oil dependence as defined above (OIL), and the relative ranking of external and internal variables from table 6.1 (EXINT), equal to the external rank minus the internal rank, yields

$$\underset{(3.1)}{\beta\hat{p} = .52} - \underset{(3.6)}{.97}|\beta u| + \underset{(3.1)}{.87}\ \text{OIL} - \underset{(5.5)}{.17}\ \text{EXINT}, \qquad R^3 = .87.$$

This equation is plotted as a line in figure 6.2, where OIL and INT are evaluated at the means for seven countries, excluding Canada, the Netherlands, and the United Kingdom. Japan and Sweden appear to have placed relatively more weight on unemployment than inflation; the United States, Italy, and perhaps France are in an intermediate position; while Belgium and Germany appear to have placed relatively low weight on unemployment relative to inflation. This certainly accords with at least some of my preconceptions.

Figure 6.2 and the average ranks for the internal variables in table 6.1

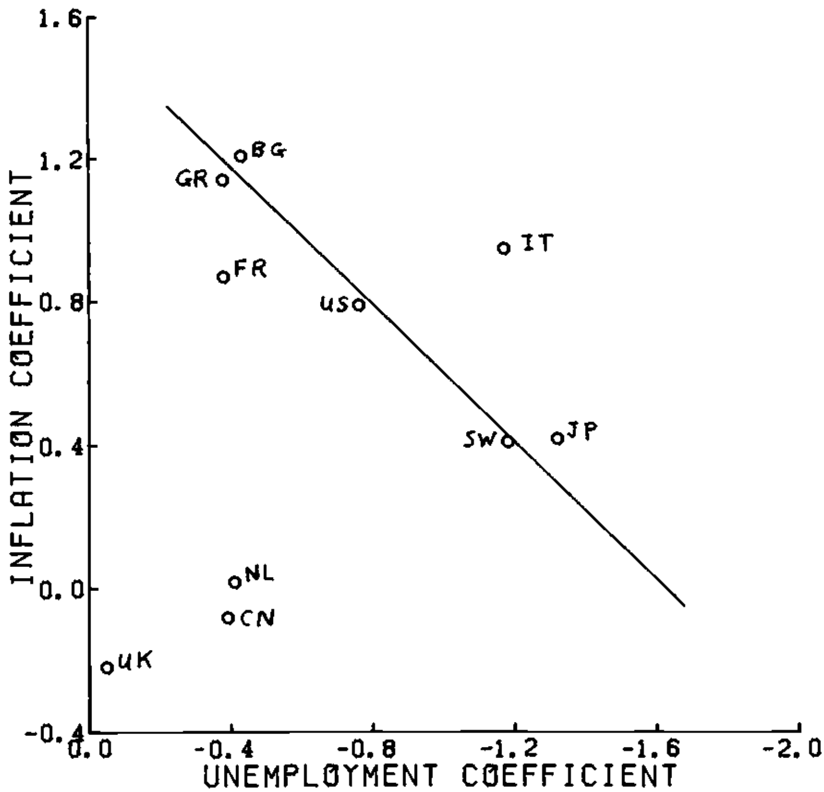

Fig. 6.2

also suggest that the United Kingdom, Canada, and the Netherlands have placed relatively little weight on internal targets, so we might expect these countries to have placed relatively higher weights on their external targets. Conversely, since the other countries seem to have placed rather higher weights on their internal targets, we might expect to find them having relatively lower weights for external variables. Note that Italy, by placing higher weights on both internal targets, may have changed its policies too frequently, contributing to its policy failure.

It is inevitably somewhat harder to summarize the results for the four external variables, as compared to the two internal variables. The United Kingdom has consistently high weights for the external variables, as generations of economists have learned to know. Similarly, the United States has consistently low weights for external variables, again as the folklore has it. Italy also has pretty consistently low weights for the external targets, as expected from its high weighting for internal targets.

Aside from these extreme cases, we see that Germany places little weight on reserves or the current account balance, but does respond to relative price and relative interest rate differentials. One might argue that this shows a tendency to anticipate external imbalance problems before they show up in the balance of payments. The Netherlands shows a similar, but weaker, pattern. By contrast, France and Japan place relatively more weight on the current account, while Sweden and Canada emphasize the level of reserves. These countries appear more likely to wait until they get into balance of payments troubles before taking action. The difference between current account and reserve weights might be attributed to a greater willingness to place Swedish and Canadian bond issues in international markets, making current account imbalance a less significant problem. Perhaps these two small countries have become more accustomed to foreign borrowing.

A noticeable inverse relationship exists between the importance of internal and external targets, as mentioned earlier. Figure 6.3 plots the average ranking of internal and external targets for each country, which has Spearman rank correlation of $-.75$. Figure 6.3 suggests the conjecture that countries with extreme weightings, either on external or internal targets, may do less well than others, since the United Kingdom and Italy appear at either extreme.

These conclusions from the discount rate equations concerning the relative importance of different targets for different countries are, broadly speaking, confirmed by examination of the other instruments of monetary policy. Domestic inflation does not appear to be an important target for the United Kingdom, Canada, or the Netherlands for any of the instruments. Sweden and Japan's low weights for inflation are confirmed, as well as Beglium and France's relatively high weights.

Canadian and Swedish emphasis on reserve targets holds across all instruments, though the current account appears to some extent as well. Belgium, like Germany and the Netherlands, appears to weight relative foreign price competitiveness significantly as an external target for its credit controls and discount quotas.

The *political variables* discussed in appendix D are frequently quite significant and play an important role in allowing determination of the policy reaction functions. Some earlier work which omitted them found, in general, less significant effects for the policy targets. Particularly noticeable influences can be seen for the U.S. external policy constraints on Canada, and for the shifts in electoral power in France, Italy, the Netherlands, Sweden, and the United Kingdom. The general conclusion is that more conservative governments were more willing to tighten monetary policies, which is certainly not surprising. An alternative interpretation is that more "socialist" influence tended to ease monetary policy, leading to inflation and changes in election outcomes in favor of conservative policies.

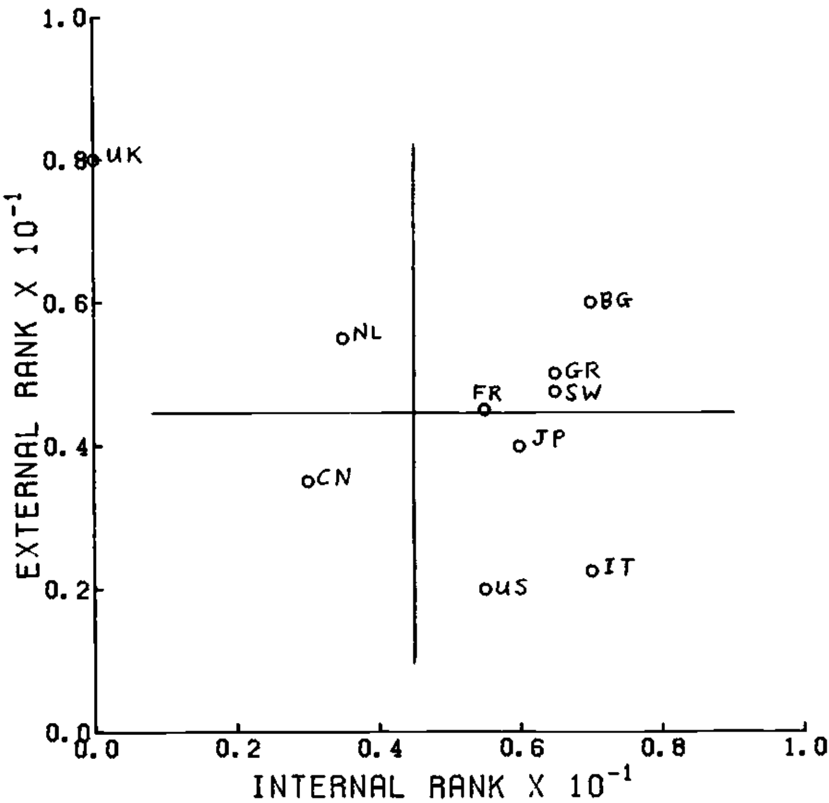

Fig. 6.3

The effects of *floating exchange rates* during the 1970s have been examined by splitting the sample at the beginning of the floating rate period for each country and by including dummy variables for specific episodes of floating prior to the adoption of generalized floating rates in 1973. While the specific dummy variables show only modest effects, the split samples for the discount rate equations (not shown here) demonstrate a pattern of greater emphasis on internal variables and less emphasis on external variables during the floating rate period for Belgium, Germany, and, to some extent, for Japan and the United States. This is, of course, what one would expect. On the other hand, the relative importance of internal and external variables appeared to shift in favor of external variables for the Netherlands, which, like Belgium, was pegged to the deutsche mark in the European Economic Community Narrow Margins Agreement, or EEC Snake. The difference between the two countries in the floating rate period thus appears to reinforce the overall difference in their focus described earlier. One may also observe that the

Netherlands emphasis on external targets was accompanied by several revaluations within the Snake, while Belgium has devalued since the beginning of the European Monetary System in 1979.

It is also of interest to compare the floaters versus the peggers. From figure 6.3, we see that the two smallest and most steadfast Snake members, Belgium and the Netherlands, have the second highest average ranking of external variables after the United Kingdom. Sweden, Germany, and France, the other Snake members, give at least moderate attention to external variables. With the exception of the United Kingdom, the other floaters tend to have lower than average rankings for external variables and, with the exception of Canada, higher than average rankings for internal variables. A cross-section regression of external rank (EXTRANK), defined as ten minus the average external rank in the last line of table 6.1, yields

$$\text{EXTRANK} = 5.15 - \underset{(4.2)}{2.21F} + \underset{(5.8)}{5.06\,\text{UK}}, \qquad R^2 = .85,$$

where $F = 1$ for floaters, 0 otherwise, and UK = 1 for United Kingdom, 0 otherwise. The anomalous results for Britain may be explained by impressionistic evidence that both the instruments and the objectives of British monetary policy have fluctuated sharply over the period. From heavy concentration on external objectives relative to a pegged exchange rate in the 1960s, Britain apparently shifted policy emphasis to internal objectives with a floating rate during 1972–76. Following an IMF standby agreement in late 1976, policy seems to have shifted back in the direction of external objectives with a quasi-pegged exchange rate during much of 1977. More work is needed to sort out these shifts.

The sign of the relative price competitiveness variable p/ep^* is also tied up with exchange rate objectives, as noted earlier. Reduced competitiveness as measured by an increase in the relative price of domestic goods leads to significantly tighter monetary policy for at least one instrument in all countries except the United States and Italy. In those two cases reduced competitiveness seems to lead to easier policy, which suggests that competitiveness would be restored by letting the exchange rate depreciate. This suggestion is strengthened by the split-sample finding that the variable has a positive sign for the United States during the pegged rate period and a negative sign during the floating period.

Perhaps the most interesting equation in table 6.A.1 (appendix C) is the one for the changes in U.S. unborrowed reserves adjusted for changes in reserve requirements. The overall equation is rather weak, but both unemployment and the reserve/import ratio have the wrong signs, suggesting that open market operations have been procyclical. Since there is substantial controversy over the interpretation of U.S. monetary policy, when comparing interest rates and monetary aggregates, this may not be too surprising. Nevertheless, it is interesting to observe this indication of the conflict between "monetarist" and "Keynesian" interpretations of policy. The comparable equations for Canada (DNDA) and Germany (DMPD) have correct signs for unemployment.

6.6 Conclusions

In addition to the individual country patterns of monetary policy, several general findings have emerged from this study. (a) There is an inverse correlation between the importance given to inflation objectives in formulating monetary policy in different countries and observed rates of inflation in the 1970s. (b) The importance attached to inflation and unemployment objectives varies inversely across countries. (c) There appears to be little relationship across countries between the importance of unemployment objectives and observed rates of unemployment. (d) There is an inverse correlation across countries between the importance of internal and external objectives for monetary policy. (e) There is an inverse correlation between the flexibility of the exchange rate and the relative importance of external compared to internal objectives. This finding holds both over time, comparing periods of pegged rates and floating rates, and across countries, comparing peggers with floaters. (f) Finally, conservative election victories have often led to tighter monetary policies, following easier monetary policies influenced by "socialist" electoral strength.

Appendix A Threshold Regression

The Inconsistency of the Least-Squares Estimator

The threshold model[5] can be stated in terms of a latent structure

(A1) $$y_t^* = \alpha + \beta' x_t + \epsilon_t, t = 1, \ldots, T, \epsilon_t \sim N(0, \sigma^2),$$

which is assumed to satisfy all of the assumptions of the multivariate normal regression model. The observed dependent variable, however, obeys the law

(A2) $$\Delta y_t = y_t^* - y_{t-1} \text{ if } |y_t^* - y_{t-1}| \geq k, \quad = 0 \text{ otherwise.}$$

5. This approach, an extension of the work of W. H. Greene, was suggested by R. Olsen and developed by the author (1981).

The underlying variables of (A1) are assumed to be jointly and normally distributed, according to

(A3) $$\begin{bmatrix} y^* \\ x \end{bmatrix}_t \sim N_h\left[\begin{pmatrix} \mu \\ \mu_x \end{pmatrix}, \begin{pmatrix} \sigma_*^2 & \sigma_{*x} \\ \sigma_{x*} & \Sigma_{xx} \end{pmatrix}\right],$$

for all t. The normality assumption on the dependent variable is standard; that on the independent variables is necessary for the derivation of truncated covariances below.

Ordinary least squares (OLS) applied to an observed random sample (y_t, x_t'), $t = 1, \ldots, T$ yields the estimates

(A4) $$\begin{bmatrix} a \\ b \\ R^2 \\ s^2 \end{bmatrix} = \begin{bmatrix} \bar{y} - b'\bar{x} \\ S_{xx}^{-1}S_{xy} \\ b'S_{xy}/S_{yy} \\ (S_{yy} - b'S_{xy})/(n-h) \end{bmatrix},$$

using standard notation for the sample moments. To derive the asymptotic bias of the OLS estimators, I follow the approach developed by Greene (1981) for the Tobit case, mutatis mutandis. From (A2) we have

(A5) $$E(y_t) = E(y_t^* \| y_t^* - y_{t-1}| \geqq k)P(|y_t^* - y_{t-1}| \geqq k) + y_{t-1}P(|y_t^* - y_{t-1}| < k).$$

Transforming to $z_t = y_t - y_{t-1}$, $z_t^* = y_t^* - y_{t-1}$, defining $\mu_* = \mu - y_{t-1}$, and dropping subscripts, we can rewrite (A5) as

(A6) $$\begin{aligned} E(z) &= E(z^* \| z^*| \geqq k)P(|z^*| \geqq k) \\ &= E(z^*|z^* \geqq k)P(z^* \geqq k) + E(z^*|z^* \leqq -k)P(z^* \leqq -k) \\ &= E(z^*|z^* \geqq k)P(z^* \geqq k) - E(-z^*|-z^* \geqq k)P(-z^* \geqq k) \\ &= \mu_*(\Phi_1 + \Phi_2) + \sigma_*(\phi_1 - \phi_2), \end{aligned}$$

where Φ and ϕ are the standard normal cumulative distribution and density functions evaluated at $(k - \mu_*)/\sigma_*$ and $-[(k + \mu_*)/\sigma_*]$ (see fig. 6.A.1):[6]

6. $$P(z^* \geqq k) = 1 - \Phi\left(\frac{k - \mu^*}{\sigma_*}\right),$$

and

$$P(-z^* \geqq k) = 1 - \Phi\left(\frac{k + \mu_*}{\sigma_*}\right) = \Phi\left(-\frac{k + \mu_*}{\sigma_*}\right).$$

The derivation of (A6) utilizes the movements of the truncated normal distribution: $E(z^*|z^* \geqq L) = \mu_* + \sigma_*\pi$, and $V(z^*|z^* \geqq L) = \sigma_*^2(1 + \ell\pi - \pi^2)$, where $\ell = (L - \mu_*)/\sigma_*$, and $\pi = \phi(\ell)/[1 - \Phi(\ell)]$ (see Johnson and Kotz 1970, pp. 81–82.

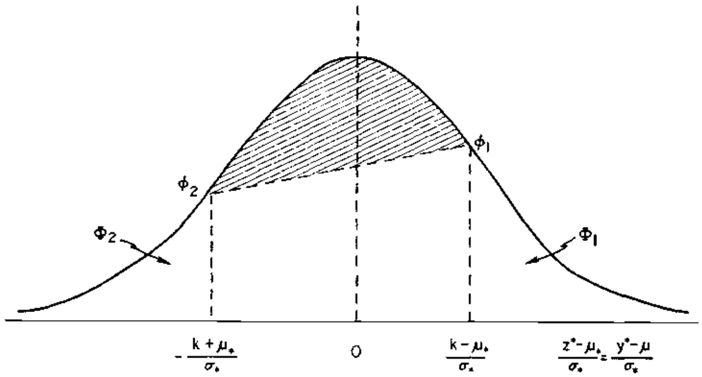

Fig. 6.A.1

$$\Phi_1 = \Phi\left(\frac{\mu_* - k}{\sigma_*}\right) = 1 - \Phi\left(\frac{k - \mu^*}{\sigma_*}\right), \phi_1 = \phi\left(\frac{k - \mu_*}{\sigma_*}\right),$$

$$\Phi_2 = \Phi\left(-\frac{k + \mu_*}{\sigma_*}\right) = 1 - \Phi\left(\frac{k + \mu^*}{\sigma_*}\right), \phi_2 = \phi\left(-\frac{k + \mu_*}{\sigma_*}\right),$$

Furthermore,

(A7)
$$\begin{aligned} V(z) &= E(z^2) - [E(z)]^2 = \Phi_1 E(z^{*2} | z^* \geqq k) \\ &+ \Phi_2 E(z^{*2} | z^* \leqq -k) - [E(z)]^2 \\ &= \Phi_1[V(z^* | z^* \geqq k) + E(z^* | z^* \geqq k)^2] \\ &+ \Phi_2[V(z^* | z^* \leqq -k) + E(z^* | z^* \leqq -k)^2] - [E(z)]^2 \\ &= \sigma_*^2 \Bigg\{(\Phi_1 + \Phi_2) + \frac{k}{\sigma_*}(\phi_1 + \phi_2) \\ &- \left[(\phi_1 - \phi_2) - \frac{\mu_*}{\sigma_*}(1 - \Phi_1 - \Phi_2)\right] \\ &\times \left[(\phi_1 - \phi_2) + \frac{\mu_*}{\sigma_*}(\Phi_1 + \Phi_2)\right]\Bigg\} = \sigma_*^2(B - r_1 r_2), \end{aligned}$$

introducing the symbols B, r_1, r_2 for convenience.[7]

(A8)
$$\begin{aligned} C(x, z) &= E(x, z) - E(x)E(z) \\ &= \Phi_1\{C(x, z^* | z^* \geqq k) + E(z^* | z^* \geqq k)[E(x | z^* \geqq k) \\ &- \mu_x]\} + \Phi_2\{C(x, z^* | z^* \leqq -k) \\ &+ E(z^* | z^* \leqq -k)[E(x | z^* \leqq -k) - \mu_x]\}. \end{aligned}$$

7. Note that B is equal to the unshaded area of figure 6.A.1; $r_2 = Ez/\sigma_*$, $r_1 = r_2 - \mu/\sigma_*$.

The conditional covariance terms in (A8) are evaluated, following Greene (1981), by using the assumption of joint normality of x and z^* to apply the following theorem (see Johnson and Kotz 1972, p. 70). For random variables u_1 and u_2 with $E(u_1) = 0$, $E(u_2) = 0$, $V(u_1) = \Sigma_{11}$, $V(u_2) = \Sigma_{22}$, $C(u_1, u_2) = \Sigma_{12}$, such that $E(u_2|u_1)$ is linear in u_1 and $V(u_2|u_1)$ is constant, under any type of selection on u_1,

$$E\begin{bmatrix} u_1 \\ u_2 \end{bmatrix} \text{selection on } u_1 \Bigg] = \begin{bmatrix} \eta_1 \\ \Sigma_{12}'\Sigma_{11}^{-1}\eta_1 \end{bmatrix},$$

and

$$V\begin{bmatrix} u_1 \\ u_2 \end{bmatrix} \text{selection on } u_1 \Bigg] = \begin{bmatrix} \Omega_{11} & \Omega_{11}\Sigma_{11}^{-1}\Sigma_{12} \\ \Sigma_{12}'\Sigma_{11}^{-1}\Omega_{11} & \Sigma_{22} - \Sigma_{12}'(\Sigma_{11}^{-1} - \Sigma_{11}^{-1}\Omega_{11}\Sigma_{11}^{-1})\Sigma_{12} \end{bmatrix},$$

where $\eta_1 = E(u_1|\text{selection on } u_1)$, and $\Omega_{11} = V(u_1|\text{selection on } u_1)$. In our case $u_1 = z^* - \mu_*$, $u_2 = x - u_x$, and selection is either according to $z^* \geqq k$ or $z^* \leqq -k$, so that $\eta_1 = E(z^* \| z^* | \geqq k) - \mu_*$. Applying the theorem to determine the components of (A8), we find

$$\begin{aligned} C(x, z^*|z^* \geqq k) &= (\sigma_{x^*}/\sigma_*^2)V(z^*|z^* \geqq k) \\ &= \sigma_{x^*}\left[1 + \frac{k - \mu_*}{\sigma_*}\frac{\phi_1}{\Phi_1} - \left(\frac{\phi_1}{\Phi_1}\right)^2\right], \end{aligned}$$

(A9) $$\begin{aligned} C(x, z^*|z^* \leqq -k) &= (\sigma_{x^*}/\sigma_*^2)V(z^*| \leqq -k) \\ &= \sigma_{x^*}\left[1 + \frac{k + \mu_*}{\sigma_*}\frac{\phi_2}{\Phi_2} - \left(\frac{\phi_2}{\Phi_2}\right)^2\right], \end{aligned}$$

and

$$E[(x|z^* \geqq k) - u_x] = (\sigma_{x^*}/\sigma_*^2)[E(z^*|z^* \geqq k) - \mu_*] = \frac{\sigma_{x^*}}{\sigma_*}\cdot\frac{\phi_1}{\Phi_1},$$

(A10) $$\begin{aligned} E[(x|z^* \leqq -k) - u_x] &= (\sigma_{x^*}/\sigma_*^2)[E(z^*|z^* \leqq -k) - \mu_*] \\ &= (\sigma_{x^*}/\sigma_*^2)[-E(-z^*|-z^* \geqq k) - \mu_*] = -\frac{\sigma_{x^*}}{\sigma_*}\cdot\frac{\phi_2}{\Phi_2}, \end{aligned}$$

Substituting into (A8) and collecting terms, we find

(A11) $$C(x, z) = \sigma_{x^*}\left[\Phi_1 + \Phi_2 + \frac{k}{\sigma_*}(\phi_1 + \phi_2)\right].$$

To find the inconsistency of the OLS estimators (A4), we need the population parameters, which by normality (A3) are

(A12)
$$\begin{bmatrix} \alpha \\ \beta \\ \rho_*^2 \\ \sigma^2 \end{bmatrix} = \begin{bmatrix} \mu - \beta'\mu_x \\ \Sigma_{xx}^{-1}\sigma_{x^*} \\ \sigma_{x^*}'\Sigma_{xx}^{-1}\sigma_{x^*}/\sigma_*^2 \\ \sigma_*^2 - \beta'\sigma_{x^*} \end{bmatrix}.$$

Therefore,

(A13)
$$p\lim b = \Sigma_{xx}^{-1}C(x, y) = \Sigma_{xx}^{-1}C(x, z)$$
$$= \Sigma_{xx}^{-1}\sigma_{x^*}\left[\Phi_1 + \Phi_2 + \frac{k}{\sigma_*}(\phi_1 + \phi_2)\right]$$
$$= \beta\left[\Phi_1 + \Phi_2 + \frac{k}{\sigma_*}(\phi_1 + \phi_2)\right] = \beta B,$$

or

(A14)
$$p\lim(b - \beta) = -\beta\left[1 - \Phi_1 - \Phi_2 - \frac{k}{\sigma_*}(\phi_1 + \phi_2)\right] = -\beta(1 - B).$$

As k goes to zero, figure 6.A.1 indicates that the bias factor in (A14) vanishes and we revert to a classical regression problem. More generally, however, the OLS estimator b is proportionally biased downward toward $\mathbf{0}$.

Consistent Estimation of the Parameters

Having derived expressions for the inconsistency of the OLS estimators for each of the model's parameters, we need only to estimate the biases from the sample data to provide consistent estimators of the parameters. Applying Greene's (1981) suggestion for the Tobit case to the present model, the sample proportions of observed increases, P_1, and decreases, P_2, in the dependent variable are unbiased, consistent estimators of Φ_1 and Φ_2. Referring to figure 6.A.1, if it happened that $P_1 = P_2$, we have $\hat{\mu}_* = 0$, and $-(\hat{k}/\sigma_*) = \Phi^{-1}(P_2)$ would be a consistent estimator of the threshold in units of σ_*. In general, $(\hat{k} - \hat{\mu}_*)/\sigma_* = \Phi^{-1}(1 - P_1)$, and $-[(\hat{k} + \hat{\mu}_*)/\sigma_*] = \Phi^{-1}(P_2)$, so that

(A15)
$$\frac{\hat{\mu}_*}{\sigma_*} = -\frac{1}{2}[\Phi^{-1}(1 - P_1) + \Phi^{-1}(P_2)],$$

(A16)
$$\frac{\hat{k}}{\sigma_*} = \frac{1}{2}[\Phi^{-1}(1 - P_1) - \Phi^{-1}(P_2)].$$

Then ϕ_1 and ϕ_2 can be consistently estimated by

$$f_1 = \phi\left(\frac{\hat{k} - \hat{\mu}_*}{\sigma_*}\right)$$

and

$$f_2 = \phi\left(-\frac{\hat{k} + \hat{\mu}_*}{\sigma_*}\right).$$

These results enable estimation of the bias factor B and r_1 and r_2 defined implicitly in (A7).

Autoregressive Explanatory Variables

In time series applications of the threshold model, the explanatory variables $\mathbf{x}_t$ are unlikely to be independently distributed over time, as required by the theorem used above to develop the covariance results. For example, suppose that the $\mathbf{x}$'s of (A1) follow the autoregressive process

$$\text{(A17)} \qquad \mathbf{x}_t = A\mathbf{x}_{t-1} + \mathbf{w}_t,\ \mathbf{w}_t \sim N_{h-1}(\mu_w, \Sigma_{ww}),$$

which could serve to model typical time series processes. Then the $\mathbf{x}_t$ process is a moving average of normal variables and is likewise normal, with an autocovariance function that can be expressed in terms of the parameters of (A17).

More generally, if we can assume that the $h + 1$ dimensional stochastic process $(y_t^*, \mathbf{x}_t')$ is covariance stationary, then the Wold theorem (Malinvaud, p. 435; or Sargent 1976, p. 257) implies that a moving average representation exists of the form

$$\begin{bmatrix} y_t^* \\ \mathbf{x}_t \end{bmatrix} = \begin{bmatrix} c_{**}(L) & \mathbf{c}'_{*x}(L) \\ \mathbf{c}_{x*}(L) & c_{xx}(L) \end{bmatrix} \begin{bmatrix} v_t \\ \mathbf{w}_t \end{bmatrix} + \begin{bmatrix} d_{1t} \\ \mathbf{d}_{2t} \end{bmatrix},$$

where $c_{ij}(L)$ is a polynomial in the lag operation L; v_t and $\mathbf{w}_t$ are serially uncorrelated random variables, such that $E(v_t) = 0$, $E(\mathbf{w}_t) = \mathbf{0}$, $V(v_t) = \sigma_v^2$, $V(\mathbf{w}_t) = \Sigma_{ww}$; and d_{1t}, $\mathbf{d}_{2t}$ are deterministic processes of time. We may as well assume also that $(v_t, \mathbf{w}_t')$ are jointly and normally distributed. Under such conditions, the innovations or prediction errors,

$$\text{(A18)} \qquad \begin{aligned} \tilde{y}_t &= y_t^* - E(y_t^* | y_{t-1}^*, \ldots, \mathbf{x}_{t-1}, \ldots) = c_{**}^0 v_t + \mathbf{c}_{*x}^{0\prime} \mathbf{w}_t \\ \tilde{\mathbf{x}}_t &= \mathbf{x}_t - E(\mathbf{x}_t | y_{t-1}^*, \ldots, \mathbf{x}_{t-1}, \ldots) = \mathbf{c}_{x*}^0 v_t + c_{xx}^0 \mathbf{w}_t, \end{aligned}$$

satisfy the requirements of the theorem used above. Specializing to the autoregressive process (A17), it is easy to show that (A1) is equivalent to

$$\text{(A19)} \qquad \tilde{y}_t^* = \beta' \tilde{\mathbf{x}}_t + \epsilon_t,$$

where $\tilde{y}_t^* = y_t^* - \alpha - \beta' A\mathbf{x}_{t-1}$, $\tilde{\mathbf{x}}_t = \mathbf{x}_t - A\mathbf{x}_{t-1} = \mathbf{w}_t$. Thus the OLS regression may be decomposed into an autoregressive part,

$$\text{(A20)} \qquad \hat{y}_t = a + \mathbf{b}'\hat{A}\mathbf{x}_{t-1},$$

and an innovation part with the autoregressive part removed,

$$\text{(A21)} \qquad \tilde{y}_t = \mathbf{b}'\tilde{\mathbf{x}}_t + e_t.$$

Note that the regression coefficients are the same in both (A20) and (A21) and correspond to the usual OLS estimates, while other statistics such as R^2, s^2, etc., will differ between innovation regression and the OLS regression.

Appendix B Institutions

Belgium has occasionally used credit controls (CC) and special reserve requirements (RR) on the banks in addition to its regular instruments, which are the discount rate (RD) and variable discount quotas (DQ) for individual banks' borrowing from the central bank. Threshold models are used for the latter two instruments and a logit approach for the first two.

Canada uses a variable secondary reserve ratio (RQ), in addition to the discount rate and open market operations (OMO), which affect the net domestic assets (NDA) of the central bank, as a component of the monetary base. The Canadian economic environment has also been significantly affected by the Quebec Separatist election victory in 1978, by a ceiling on its allowed holdings of international reserves agreed with the United States during 1965–68, and by the effects of U.S. efforts to control capital outflows during 1968–74.

France has at various times utilized both reserve requirements on bank liabilities and credit controls to limit the growth of credit. The credit controls, known as the *encadrement du crédit*, impose progressively higher reserve requirements on individual banks that exceed prescribed norms for the growth of nonexempt or controlled credit. A measure of the stringency of the controls, called the *morsure* or "bite," has been constructed by the Banque de France, making use of business opinion surveys on the difficulty of obtaining credit and objective evidence on the growth of credit relative to the ceilings, (exempt) lending to residents in foreign currency, and various measures for the slowing of payments. A threshold approach is used for the "bite" and for the discount rate, while a logit model is used for the adoption of credit controls or reserve requirements. Several political factors have had important effects on the economic environment, including the strikes of May 1968, President Giscard d'Estaing's promise to restore the franc to the Snake after his election as president in 1974, and the center-right victory in the Parliamentary elections of 1978.

Germany utilizes open market operations, changes in discount quotas and reserve requirements, as well as changes in reserves on foreign liabilities of commercial banks and nonbanks (the "Bardepot"). The first three of these are combined with changes in currency (CURR) and government cash (GCSH) balances into a domestic monetary policy measure reflecting policy-induced changes in the monetary base, or central bank money (CBM), as OMO + ΔDQ − ΔRR − CURR − GCSH.

The last two items are combined into a foreign monetary policy measure. In addition, foreign currency swaps at favorable rates were often used to induce commercial banks to switch liquid asset holdings abroad.

Italy differs from other countries in having failed to use the discount rate until 1969, when the policy of pegging interest rates was abandoned. Since 1973 a more or less continuous policy of ceilings on bank lending has been utilized, but equally continuous pressure to provide credit to the public sector has kept the ceilings from being very useful. Required reserves, both on domestic liabilities (RR) and on foreign liabilities (RF), particularly in the form of prior deposits for imports in 1974 and 1976, have been more effective measures of policy. Much rhetoric concerning the monetary base and the control of "total domestic credit" has apparently been of little effect.

Several other shifts in the use of monetary policy instruments affected those referred to above, in particular the frequent use of controls over banks' net foreign asset positions (BFP), a major reduction in the required reserve ratios in 1965 (DRR), and the constraints imposed by the 1977 standby credit agreement with the International Monetary Fund (IMF).

A number of political factors have been examined for their effects on monetary policy, including the beginning of political instability marked by the end of the Socialist-Christian Democratic coalition, the fall of the Moro government in 1968, and the period of Communist influence over the Christian Democratic government between the Communist election victory of 1976 and their defeat of 1978.

Japan has placed heavy emphasis on credit controls through a process known as "window guidance," which is measured by the quarterly percentage increase or decrease specified by the Bank of Japan in the annual rate of change in individual banks' loan portfolios (WG). In addition, reserve requirements have been varied and, to a minor extent, open market operations have been utilized, especially since 1966. During late 1969, the so-called yen-shift operations to promote repayment of foreign borrowings were encouraged.

The Netherlands has utilized a variable secondary reserve ratio (RQ) since 1973, in addition to open market operations. Prior to and during 1973, a system of required primary reserves was used on occasion. In addition, credit controls have also been imposed at times. Other factors influencing monetary policy have included occasional periods in which the Dutch guilder floated prior to 1973 and two extended periods in 1972–73 and 1977 during which the Netherlands functioned without an elected government.

Sweden has utilized a secondary reserve ratio (RQ) as well as credit controls over bank lending (CC) and primary reserve requirements (RR) in its conduct of monetary policy. In addition, firms are permitted to make investment deposits (INV) in the central bank, tax free, out of profits which are retained for future investment purposes. These deposits are then released by the central bank to the firms in accordance with monetary policy objectives. The main political shift affecting the Swedish economic environment has been the replacement of the Social Democratic government that had been in power for forty years with its "bourgeois" opposition in 1976. In August 1977, the Swedish krona floated out of the EEC Snake.

The United Kingdom made a major change in its quantitative monetary policy instruments with the adoption of the Competition and Credit Control Act in 1971 (CCC), which sought to abolish a system of informal credit controls on the banks in favor of renewed use of a reserve ratio system, including however a substantial reduction in the reserve ratio at the same time. The resulting credit expansion, in conjunction with an endogenous reserve base and an initial willingness to see a substantial growth of bank credit, led to a reimposition of credit controls via supplementary special deposits (the "corset") in December 1973. The "corset," unlike the French "encadrement," imposes increasing reserve requirements on banks whose liabilities rise above specified ceilings. Another factor seriously affecting the conduct of British monetary policy was the need to support via domestic monetary policy the major devaluation of the pound sterling in 1967. Finally, there have been increasingly sharp shifts in the course of both monetary and fiscal policy associated with the changes in government between the Labor and Conservative parties in 1970, 1974, and 1978.

The *United States* has traditionally utilized open market operations as its chief monetary policy tool, aiming to influence short-term interest rates and the rate of expansion of bank credit and the money supply by changing unborrowed reserves (NB) available to the domestic banking system. As reserve requirements have also been changed at various times, the measure of unborrowed reserves is adjusted to allow for the implied changes in the demand for high-powered money. In November 1978 a major shift in the orientation of domestic monetary policy more toward external objectives was combined with a large increase in the scale of exchange market intervention. Again in October 1979 a further change in monetary policy shifted the main short-run target to allow much greater flexibility in interest rates. In addition, monetary policy has operated in somewhat different environments during the period of wage and price controls, known as the New Economic Policy (NEP), during 1971–72, and during the 1968–73 period of capital controls over the balance of payments, and during the collapse of the Franklin National Bank in 1974.

Appendix C

Table 6.A.1 Monetary Policy Reaction Functions for Ten Industrial Countries

	$\hat{p}_{-1}$ (+)	u_{-1} (−)	gap_{-1} (−)	$(f/m)_{-1}$ (−)	$(x/m)_{-1}$ (−)
Belgium					
RD	.87	−.31	—	−.58	−1.33
6302–7911	(4.2)	(4.6)		(1.5)	(1.3)
		−1.36 RR (5.3)			
RRCC	−.59	−2.15	−34.1	−.02	1.97
6302–7911	(.8)	(5.2)	(3.4)	(.01)	(.6)
DQ	−6.34	6.27	−75.9*	8.11*	5.12
6905–7911	(4.4)	(9.1)	(6.3)	(2.5)	(.9)
		−4.66 CC (1.9) +7.21 RR (4.0)			
Canada					
RD	−.06	−.28	—	−1.20	1.08
6302–7911	(.3)	(2.8)		(7.2)	(1.1)
		+2.59 QUE (6.3) −1.02 USRES (4.0)			
DNDA	−.57	−.46	—	1.62* −.35FL[a]	−2.2 + 13.4FL[a]
6302–7911	(1.0)	(1.4)		(2.3) (.4)	(.5) (2.9)
		−3.96 QUE (3.4) −1.24 USBOP (1.7)			
RQ	.06	−.23	−7.48	.80	1.91
6906–7911	(.5)	(2.5)	(3.9)	(7.9)	(2.9)
France					
RD	.46	−.20	—	−.42	−3.59
6401–7911	(2.0)	(6.6)		(3.2)	(3.2)
		+2.08 GISC (7.9) −1.10 MAY 68 (1.2)			
RRCC	2.63	−.65	—	7.49*	−11.6
6302–7911	(2.4)	(3.0)		(4.8)	(1.9)
BITE	.66	−.09	—	.07	−6.79
6302–7911	(2.5)	(2.6)		(.5)	(5.2)
		+.81 ELECT (2.1) −1.00 MAY 68 (.9)			

$(p/ep^*)_{-1}$ ±	r^* +	t	$\bar{R}^2/P(B)$	$se/d(h)$	Method
.01	.26	.024	.64	.98	Thres.-OLS
(.5)	(6.9)	(6.7)	.25(.72)	.39	
.26	.31	.056	.63	.30	Logit
(2.9)	(1.7)	(3.9)	.89	—	
−.65	—	−.36	.88	4.55	Thres.-OLS
(3.3)		(5.7)	.58(.96)	.91	
.01	—	.018	.82	.94	Thres.-OLS
(.8)		(4.8)	.24(.71)	.21	
	dnfa				
.07 − .16FL[a]	−.98 + .25FL[a]	.05	.47	2.36	OLS
(1.2) (3.1)	(7.6) (1.6)	(2.6)		2.65	
.16	—	−.018	.93	.42	Thres.-OLS
(.2)		(4.9)	.06(.337)	.66	
−.92	.15	.046	.90	.88	Thres.-OLS
(.2)	(4.4)	(14.4)	.14(.53)	.52	
.37	1.68	.09	.67	.24	Logit
(3.4)	(3.7)	(3.9)	.92		
.06	—	.006	.23	1.05	Thres.-OLS
(2.3)		(2.7)	.41(.88)	.31	

Table 6.A.1 continued

	$\overset{+}{\hat{p}_{-1}}$	$\overset{-}{u_{-1}}$	$\overset{-}{gap_{-1}}$	$\overset{-}{(f/m)_{-1}}$	$\overset{-}{(x/m)_{-1}}$
Germany					
RD	.72	−.24	—	.04	−.09[b]
6402–7911	(3.4)	(3.2)		(.5)	(1.0)
		−1.25 SWAP (7.6)			
DMPD SA	.07	.06	—	−.01	−.09[b]
6402–7911	(.7)	(2.2)		(.5)	(2.9)
		+.33 NIX (1.6) −.18 DMFL (1.1) +.11 OPEC (1.1) −.02			
DMPF SA	.01	.01	—	−.06	−.23[b]
7201–7911	(.3)	(1.0)		(2.5)	(5.8)
Italy					
RD	.82	−1.01	—	−.27	−.73
6907–7911	(4.0)	(4.6)		(1.5)	(.6)
		+2.26 COM (6.4)			
RRDC SA	−.29	−.08	.65RRDC$_{-1}$	−.05	−.008[b]
6602–7910	(1.5)	(.4)	(11.1)	(2.7)	(1.7)
RFDC SA	.32	−.17	.89RFDC$_{-1}$	−.02	−.015[b]
6602–7910	(2.2)	(1.2)	(35.3)	(1.2)	(4.6)
		+.49 COM (2.0) −1.01 IMF (4.1)			
Japan					
RD SA	.23	−6.60	8.21[c]*	−.38	−3.94
6302–7911	(2.6)	(3.7)	(4.6)	(6.3)	(6.3)
		+1.71 YENSH (8.7) −.50 OMO1 (1.9)			
RRDC SA	.03	.11	.78RRDC$_{-1}$	−.04	−1.07
6505–7911	(.9)	(.2)	(17.7)	(1.5)	(3.5)
		+.14 YENSH (1.8)			
WG	−3.6	154.3	—	3.8	83.8
6401–7906	(1.2)	(3.0)		(2.0)	(4.3)
		+55.8 OMO1 (4.4)			

$(p/ep^*)_{-1}^{\pm}$	r^{*+}	t	$\bar{R}^2/P(B)$	$se/d(h)$	Method
.03	.42	−.015	.64	.84	Thres.-OLS
(2.0)	(11.1)	(3.2)	.19(.63)	.33	
.56	—	−.004	.30	.26	OLS
(.9)		(2.7)		1.86	
SWAP (.3)					
−.001	—	.001	.29	.70	OLS
(.2)		(.9)		2.05	
−.25	−.14*	.032	.92	.99	Thres.-OLS
(9.4)	(2.8)	(5.4)	.15(.56)	.62	
−.027	.11	.009	.75	.97	OLS
(1.5)	(2.6)	(2.2)		(−4.5)	
−.06	—	.01	.99	.68	OLS
(3.2)		(3.0)		(−1.7)	
−4.10*	.09	.01	.63	.80	Thres.-OLS
(3.5)	(1.9)	(2.7)	.15(.56)	.47	
.02	—	−.009	.94	.32	OLS
(4.2)		(4.5)		(1.1)	
−2.4	—	−.32	.50	.36	Thres.-OLS
(4.3)		(1.7)		.49	

NOTE: $|t|$ ratios in parentheses; P is percent of observations with change *or* percent of correct forecasts in logit; B is bias factor; d (or h) is Durbin-Watson (or Durbin) statistic; * indicates incorrect sign.

[a]FL = 1 in floating period.

[b]dnfa.

[c]Up to 1974 only.

Table 6.A.1 continued

	$\hat{p}_{-1}$ (+)	u_{-1} (−)	gap_{-1} (−)	$(f/m)_{-1}$ (−)	$(x/m)_{-1}$ (−)
Netherlands					
RD	.01	−.26	—	.38	−1.04
6401–7906	(.1)	(2.8)		(1.4)	(1.0)
		−1.56 NOGOV (7.8) +.62 RR (2.7)			
RRDC SA	−.05	.30*	—	−.44	−.80
6302–7911	(1.1)	(3.7)		(2.1)	(1.0)
		−.26 GLFL (1.1) −.31 NOGOV (1.9) +.38v_{-1}			
RQ SA	−.55	.54*	−9.2	−.70	−5.9
7306–7907	(1.2)	(3.1)	(1.5)	(.8)	(1.5)
CC	.15	−2.14	—	−3.24	−13.5
6302–7911	(.6)	(4.6)		(3.2)	(3.2)
Sweden					
RD	.22	−.70	—	−1.02	.04
6302–7911	(3.3)	(9.3)		(12.9)	(.1)
		+1.09 BOURG (5.7) +.37 SKRFL (1.7)			
RRDC SA	−.20	−.60	—	−.57	−2.81
6701–7911	(1.2)	(2.5)		(2.8)	(2.6)
INV	.01	−.47	—	.34	−1.26
6601–7911	(.3)	(8.2)		(6.6)	(4.6)
		+3.83 INV75 (23.9) +3.57 INV79 (12.6)			
RQ	.59	.32	—	1.22	−1.14
7210–7911	(2.5)	(.9)		(3.5)	(.7)
		−3.3 BOURG (5.7)			
CC	−.62	−1.48	—	−6.91	.42
6302–7911	(.8)	(1.6)		(4.2)	(.1)
United Kingdom					
RD	−.21	−.05	—	−4.72	−9.66
63 II–79 IV	(1.6)	(.2)		(5.0)	(3.2)
		−1.46 NIX (1.5) +1.25 OPEC (1.9) +1.69 HEATH (2.9)			
RRDC	−.15	−1.25	—	−1.57	1.66
65 II–79 IV	(1.5)	(4.1)		(2.3)	(.7)
		+1.57 DEVAL (2.1) −1.94 CCC (2.4)			
United States					
RD	.55	−.53	—	−.24	.60
6401–7911	(3.5)	(10.0)		(1.2)	(1.3)
		+2.14 OPEC (6.9) −.79 NEP (4.8) +2.49 INTVN (12.2)			
DNB SA	−.01	−.03	—	−.26*	−.04
6302–7911	(.2)	(1.5)		(3.6)	(.2)
		−1.04 FRANK (7.6)			

$(p/ep^*)_{-1}^{\pm}$	r^{*+}	t	$\bar{R}^2/P(B)$	$se/d(h)$	Method
.07	.27	−.002	.68	.70	Thres.-OLS
(3.2)	(7.8)	(.8)	.19(.64)	.49	
−.01	.19	−.002	.55	.44	CORC
(.8)	(6.1)	(.9)	—	2.11	
.32	—	.02	.47	1.14	Thres.-OLS
(3.7)		(2.4)	.75(.99)	1.05	
−.26*	—	.09	.48	.36	Logit
(3.4)		(5.7)	.82	—	
.013	.03	.007	.82	.47	Thres.-OLS
(2.5)	(1.4)	(6.3)	.14(.53)	.76	
.08	.21	.08	.46	1.00	OLS
(3.8)	(4.3)	(2.8)	—	1.48	
.03	—	.02	.94	.31	OLS
(5.8)		(21.1)	—	.81	
−.05*	—	−.01	.66	1.23	OLS
(2.1)		(.5)	—	.89	
−.30*	.45	.13	.81	.20	Logit
(3.6)	(1.7)	(4.8)	.95	—	
.074	.30	.135	.85	1.15	Thres.-OLS
(2.5)	(2.7)	(3.9)	.60(.96)	1.66	
+1.29 THATCH (1.5)					
−.09*	−.26*	.12	.63	.85	OLS
(4.7)	(3.7)	(3.7)	—	1.52	
−.04	—	−.005	.93	.48	Thres.-OLS
(6.1)		(1.4)	.23(.70)	.69	
+2.24 TARGT (7.2) +1.56 CAPC (9.0)					
.004	.04dfloat*	.001	.34	.22	OLS
(1.6)	(2.2)	(1.4)	—	2.06	

Appendix D Data Sources

Sources

IFS: *International Financial Statistics* (IMF, Washington)—ℓ. indicates line number

MEI: *Main Economic Indicators* (OECD, Paris)

BCB: bulletins of the various central banks

Country Codes

BG—Belgium	JP—Japan
CN—Canada	NL—Netherlands
FR—France	SW—Sweden
GR—Germany	UK—United Kingdom
IT—Italy	US—United States

SA indicates seasonal dummies used.

Dependent Variables

BITE Index of "bite" of credit controls. FR—BCB, Sept. 1978.

CC Dummy variable for use of credit controls. NL—BCB; SW—*The Swedish Economy*.

DNB Change in unborrowed reserves, adjusted for changes in reserve requirements. US—BCB.

DMPD GR: (OMO + ΔDQ − ΔRR − ΔCURR − GCSH)/CBM (−1): open market operations plus increase in discount quota less increase in required reserves, currency, and government cash deposits, all as percent of monetary base in preceding period. OMO, ΔDQ, ΔRR—BCB; ΔCURR—IFSℓ.14a; GCSH—IFS ℓ.87; CBM—MEI.

DMPF GR: (ΔRF + BARDP)/CBM(−1): BCB for change in reserves on foreign liabilities (ΔRF) of commercial banks and "Bardepot" reserves (BARDP) on nonbank foreign liabilities.

DQ Discount quota, in domestic currency, period average. BG—BCB.

INV Investment fund deposits in central bank, domestic currency, end of period. SW—IFS ℓ.15.

DNDA Change in net domestic assets of central bank, domestic currency, end of period, as percent of monetary base in preceding period. CN—IFS ℓ.12a.

RRCC Dummy variable for use of reserve requirement or credit controls. BG, FR—BCB.

RD Central bank discount rate, percent, end of month. IFS ℓ.60.

RFDC Reserves on foreign liabilities of commercial banks, as percent of domestic credit. IT—IFS ℓ.16c/ℓ.32d for end-of-period data.

RQ Reserve ratio, in percent, period average. CN—BCB for secondary reserve ratio; NL—BCB; SW—*The Swedish Economy*.

RRDC Required reserves, as percent of domestic credit, end of month. BG—IFS ℓ.14–ℓ.14a/ℓ.32; IT—IFS ℓ.12e/ℓ.32d; JP, NL, SW—IFS ℓ.12e/ℓ.32; UK—IFS ℓ.20x/ℓ.32.

WG Window guidance, quarterly percent increase or decrease in annual rate of change of bank loans allowed by Bank of Japan. *Japan Economic Yearbook*.

Independent Variables (lagged one period, where indicated)

$\hat{p}_{-1}$ Rate of change of consumer price index. IFS ℓ.64.

u_{-1} Unemployment rate (except for FR, JP, NL—number of unemployed/number of vacancies). MEI.

gap_{-1} Manufacturing output, deviation from exponential trend with break in January 1974. IFS. ℓ.66c.

$(f/m)_{-1}$ Foreign exchange reserves/imports. IFS. ℓ.1d.d./ℓ.71d.

$(x/m)_{-1}$ Exports/imports. IFS ℓ.70d/ℓ.71d.

dnfa Change in net foreign assets of central bank. IFS ℓ.11, except IT—IFS ℓ.1d.d.

$(p/ep^*)_{-1}$ Relative normalized unit labor costs, corrected for exchange rates. IFS ℓ.65umc.

r^* Three-month Eurodollar rate of interest, in percent, end of period. IFS ℓ.60d(UK).

t Time trend.

dfloat Change in Federal Reserve float. IFS ℓ.13a(US).

Dummy Variables

BG RR—use of required reserves; CC—use of credit controls.

CN QUE—since Quebec Separatist election victory; USRES—during agreement with US on reserve ceiling; USBOP—controls on US capital account.

FR GISC—after Giscard's election before reentry into Snake; MAY 68—strikes; ELECT—since center-right election victory.

GR SWAP—availability of dollar swaps with central bank; NIX—from August to December 1971; DMFL—temporary floating exchange rate; OPEC—increased at January 1974 and January 1979.

IT COM—period of Communist strength in elections; BFP—use of controls over bank's foreign asset positions; DRR—change in required reserve ratios; IMF—period of IMF standby agreement; MOROF—fall of Moro government, beginning of greater political instability; DTC—rate of growth of domestic credit since 1974.

JP	YENSH—period of policy to aid "yen shift", repayment of foreign borrowings; OMO1—commencement of open market operations at market prices.
NL	NOGOV—periods of interregnum; RR—use of required reserve system; GLFL—floating exchange rate.
SW	BOURG—"bourgeois" parties in power; SKRFL—floating exchange rate; INV75, INV79—large-scale use of investment and liquidity deposits.
UK	NIX—from August to December 1971; OPEC—increases in January 1974 and January 1979; HEATH—Heath government; THATCH—Thatcher government; DEVAL—devaluation of pound in 1967; CCC—Competition and Credit Control introduction of new monetary control system.
US	OPEC—increases in January 1974 and January 1979; NEP—price and wage controls; INTVN—new policy of exchange market intervention; TARGT—adoption of monetary target with more flexible interest rates; CAPC—capital account controls; FRANK—loans to Franklin National Bank.

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Comment Leonardo Leiderman

With the advent of increased macroeconomic volatility in the 1970s, there has been growing interest in comparing across countries the different macro performances that have been observed. Countries differ in their macro performances because of differences in: (i) economic structures, (ii) economic shocks, and (iii) policies adopted by the authorities. A highly debated issue in this context is the relative importance of each one of these three factors in "explaining" observed differences across countries.

Black's paper presents an international comparison of the utilization of monetary policy instruments among ten leading developed countries. This comparison is made on the basis of estimated monetary policy reaction functions and it clearly constitutes a prerequisite for attempting to assess the potential empirical importance of factor (iii) above. Main distinguishing features of this investigation are: (i) the use of a relatively large amount of information (monthly data for sixteen years and ten countries); (ii) the use of a threshold regression technique; and (iii) the attempt to take into account political and institutional factors that potentially affect the conduct of monetary policy. Also, the paper's appendix B contains valuable information on the implementation of monetary policy in different countries.

In my opinion, the paper is generally useful and informative. However, I have some doubts about the meaning of the present results. These doubts arise because of the existence of potentially serious limitations in the paper's methodology and empirical analysis. I turn now to a discussion of these limitations.

Methodology

Black proposes treating the estimated reaction functions as being derived from maximization of an intertemporal welfare function of the authorities subject to a perceived econometric model of the rest of the economy (see Chow 1975). Obviously, to get estimable reaction function equations it is required to assume specific forms for both the authorities' welfare function and the economy's structure. Yet in the paper, none of these specifications are made in a degree of detail that would enable one to actually derive the estimated reaction functions—like equation (2)—from this framework of optimization. In other words, the present analysis proceeds by directly postulating the reaction function equations to be estimated, and this gives rise to several problematic issues.

First, the authorities are assumed to react to changes in inflation, unemployment, etc., only with one-month lag (provided that these

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changes exceed the pertinent thresholds). It seems to me difficult both to justify this specification as a plausible one and to relate it to the intertemporal optimization idea. The latter would imply that current monetary policy reacts not only to past changes in inflation, unemployment, etc., but also to those changes that are expected to occur in the present and future periods. It may well be that these expected changes are in turn systematically related to past changes in these variables. However, the one-month lag specification would seem to hold only under very restrictive assumptions.[1] Moreover, under the present specifications the authorities are implicitly assumed to respond to permanent and transitory shocks in inflation, unemployment, etc., in exactly the same manner—an implication that seems to be at variance with those of the intertemporal optimization framework.

Second, the present analysis treats the reaction functions postulated for the policy instruments of each country as separate equations. Instead, an explicit optimization framework—and even policymaking in practice—is likely to result in restrictions across these equations. Testing these restrictions can provide some information on the internal consistency and empirical accuracy of the optimization framework for analyzing central bank behavior in practice.

Third, other (more general) questions can be raised regarding the present specifications: (i) Why is it that foreign exchange intervention reaction functions are not considered here? Doesn't this intervention have potential monetary implications that need to be taken into account?[2] (ii) Wouldn't it be more plausible to assume that, in equation (1), the variable f represents the country's net external indebtedness than to assume that it stands for the stock of international reserves? (iii) Aren't there interactions between monetary and fiscal policies that are not taken into account here? For example, doesn't a government budget deficit have implications for monetary policy that need to be incorporated into the analysis?

Fourth, it is not at all clear how one should interpret the estimated coefficients. Theory suggests that they represent the combined influence of the effect of an instrument on a target variable and the weight of the target in the welfare function. In other words, these coefficients are generally functions of structural parameters and of parameters that capture policy preferences. Attempting to disentangle these "fundamental" parameters from the estimated coefficients may not always be possible (see, e.g., Makin 1976), and it is certainly impossible in the current setup.

1. Black claims that "the structural models all confirm that there are long lags in the effects of monetary policy instruments on the main targets, such as inflation, unemployment, and the current account of the balance of payments" (section 6.3, conclusion). Given this, how can one rationalize the paper's one-month lag specifications?

2. See Black (1980) for an econometric study of central bank intervention reaction functions.

Given this, one cannot determine whether the cross-country differences in the estimated reaction functions are mainly the result of differences in economic structures or in preferences of monetary policymakers. Yet for most potential uses of the estimated coefficients—like analyzing the importance given to a specific target in formulating monetary policy—it seems very important to attempt to disentangle the "fundamental" parameters from the econometric estimates.

Empirical Analysis

In interpreting the estimated monetary policy reaction functions, Black focuses mainly on cross-country comparisons. My main comment on the results of these comparisons is that they are not robust;[3] therefore caution is suggested in dealing with the empirical conclusions of the paper. In particular, these conclusions appear to be very sensitive to the choice of the specific countries that are considered in a given comparison.

To show that this is the case, let us turn to some of Black's main conclusions, discussed in section 6.6 of the paper. Consider the first conclusion: "There is an inverse correlation between the importance given to inflation objectives in formulating monetary policy in different countries and observed rates of inflation in the 1970s." This conclusion is based on analysis of the data plotted in figure 6.1 of the paper. To reach such a conclusion one must exclude (at least) three countries from the comparison: Canada, Italy, and the Netherlands. Although the author discusses some ad hoc reasons for excluding these countries, it seems to me that similar reasons may dictate excluding other countries from the analysis. And if we were to exclude only Belgium, Germany, and the United Kingdom, for example, it is quite possible that the abovementioned inverse correlation would change sign.

A similar phenomenon holds in the case of other conclusions, like conclusion (b), which is partially based on figure 6.2. Here Canada, the Netherlands, and the United Kingdom have been excluded from the analysis. However, if one were to include these countries in the international comparison, the present results would be altered.

A related problematic issue is the lack of use of statistical tests for significance in deriving the main conclusions of the paper. Questions of statistical significance arise at several points in the analysis. For example, how significant are the relationships depicted in figures 6.1–6.3 which gave rise to conclusions (a), (b), and (d) of the paper? Another example is conclusion (e), which deals with the relationship between the flexibility of the exchange rate and the importance attached to external versus internal objectives. This conclusion has been reached from sample splits for the different estimated equations. Are the observed subsample differ-

3. This lack of robustness holds even if one abstracts from the above comments on methodology.

ences significant? Dealing with these questions is of crucial importance in an empirical study of this nature. Otherwise the reader can only speculate on the confidence to be attached to the present results.

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Comment Alan C. Stockman

Black's paper begins with the question of why economies differ cross-sectionally in their performance. He forms a trichotomy of reasons: differences in external shocks affecting economies, differences in economic structures, and differences in economic policies. Although some economists may argue that differences in economic policies are themselves endogenously determined as the result of differences in shocks and underlying structures of economies, this trichotomy could, with certain definitions of the three categories (which Black does not provide), form an exhaustive set of reasons for differences in economic performance. Black then seeks to determine the extent to which differences in policies have accounted for differences in economic performance in recent years among a sample of OECD countries by examining the extent to which their policies have differed and by explaining those differences in policies.

The approach Black takes to cross-sectional differences in economic policies in his paper is, unfortunately, narrow. His empirical model treats differences in economic policies as differences in outcomes for (or realizations of) the central bank discount rate and other government control variables when conditions in the economy (e.g., inflation) change, rather than treating economic policies as *rules* generating these outcomes. This shows up, for example, in his use of political dummy variables (described in his appendix D) in the regression results. Two countries may differ substantially in their policies because one country may change the *relationship* between inflation (or unemployment, etc.)

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and changes in the discount rate with great frequency, while another country may maintain a more stable relationship between these variables over time. Even if the *average* relationships between inflation or unemployment and changes in the discount rate are the same in the two countries, we may think of these countries as having radically different policies because of the differences in the stability of their rules. These rules should be thought of as part of the policies pursued. If this were done, many of the ambiguous results obtained by Black (discussed below) might become easier to interpret.

Black's empirical procedure is to examine a set of variables under direct control of the government and to view these variables as functions of target variables (such as inflation and unemployment) and future expected values of these target variables. These expected future values are replaced with other variables that Black views as providing information on the state of the economy and hence on future movements in the target variables. The function is then estimated by a threshold regression technique, discussed below. Aside from issues regarding the choice of target variables, lag length, choice of control variables (such as the central bank discount rate and required reserve ratios), and sensitivity of the results to choices of dummy variables for political changes, there is an issue regarding the replacement of expected future values of the target variables by variables that are viewed by the econometrician as predictors of future values of these variables. One procedure for accomplishing the desired estimation would be to examine the observable variables that Granger-cause future movements in the target variables and to use this information to form optimal predictors, as of the current time, of these future movements. One would therefore obtain two sets of equations: one set relating current control variables to current and lagged values of all the variables in the model, and a second set describing expected future changes in the target variables as functions of current and lagged values of all the variables in the model. The equations can then be estimated simultaneously, imposing (and testing) the cross-equation restrictions imposed by the model and by the assumption of rational expectations. (Without the assumption of rational expectations, it would be impossible to place any interpretation on the estimated coefficients of the variables proxying for future changes in the targets.)

Black does not impose or test these restrictions that are implied by his model. As a consequence, the reader is left with greater uncertainty about whether the reported estimates should be viewed as reflecting structural reaction functions or as some reduced forms that could not be given the interpretations that Black would like to give them.

The interpretations that Black gives to the results do not appear to be supported by the results themselves. He claims that the results show an inverse correlation between the weights given to inflation in the reaction functions and the average inflation rates over the period, and he interprets this as evidence that countries with greater relative concern about inflation succeed at having lower inflation rates. This is illustrated in figure 6.1 in his paper, where Black treats Italy, the Netherlands, and Canada as outliers in the relationship. But one may as well treat the United Kingdom, Germany, and Belgium as outliers and conclude that the figure illustrates a positive correlation. Similarly, only by ignoring the United Kingdom, the Netherlands, and Canada can Black obtain an inverse relationship between the policy weights given to inflation and to unemployment, as illustrated in his figure 6.2. Similarly, Black makes much of rankings of coefficients in his estimated reaction functions, but these rankings are not robust with respect to the choice of the policy instrument, as can be seen by examining the results reported in his table 6.A.1 and contrasting the rankings for the discount rate equation with (say) the equation for required reserves as a percentage of domestic credit.

The sensitivity of the results to the policy instrument suggests that it would be useful to view policy as being implemented jointly through a vector of controls, rather than trying to examine a single control variable in isolation. A naive strategy would then be to employ multivariate regression techniques to the vector of controls. But a better strategy would be to model the broader aspects of the term "policy," as discussed above, and to include measures of stability or instability and measures of the ability of governments to precommit themselves to policy rules that might avoid (or be solutions to) the problems of dynamic inconsistency (discussed by Kydland and Prescott in the paper cited by Black). It would also be important to model the changing constraints on government policymakers that occur as a result of changes in the outside world or of internal changes (Black would include these under changes in structure). For example, policymakers may be forced to accept something close to the world rate of inflation (with some modifications) if they choose a regime of pegged exchange rates, and this world inflation rate may change over time, leading to changes in the relationship between internal economic variables measured by the econometrician and the values of policy instruments.

The threshold regression technique discussed in Black's paper and used to estimate the reaction functions deserves comment. First, the use of the technique in this case does not seem to make much difference to the results, as the factors by which the OLS coefficients are divided are very nearly equal across countries. Certainly the rankings of coefficients are not substantially affected by the technique. As a more general matter, the technique seems rather limited in its usefulness. The general idea of threshold regression is that the dependent variable equals some linear function of observable variables plus a disturbance if the change in the value of the dependent variable would in that case exceed some critical value. Otherwise, the value of the dependent variable is unchanged (or, more generally, it could equal some other function). The apparent motivation for the technique is that some variables are observed to undergo discrete changes and then to remain fixed for a time before another discrete change occurs. But this observation does not imply that threshold regression is an appropriate statistical technique for modeling the behavior of the variable. There are at least three obvious alternatives which may be preferable. First, the dependent variable could be modeled as a Poisson process, and the independent variables could affect either the probability of a jump over a time interval or the magnitude of the jump if it occurs or both. This would lead to a substantially different interpretation of the model than does threshold regression, and there are tests that would allow the econometrician to distinguish between these two models. Second, the probability of a change in the dependent variable could be modeled rather than modeling the actual change and using threshold regression. Under certain additional assumptions, this would reduce to the Poisson model, but these additional assumptions are not required. Third, one could explicitly develop a model that includes fixed costs of altering the dependent variable. This seems to me to be the most desirable alternative, particularly if the economist believes that some fixed costs actually underlie the discrete changes in the variable being modeled. The development of such a model would result in something rather different than the equations that Black estimates, and different than the threshold regression model. The reason is that policymakers who are optimizing subject to some fixed costs of altering the policy instrument will choose a different strategy for changing that instrument than if there were no fixed costs. Expectations of future desired changes in the instrument become more important and affect current decisions in a new way. A policymaker who expects to desire another change in the near future will be less likely to change the instrument today, and even if he does, the fixed costs of making another change will affect the magnitude of the change he makes today. The inherently static decision-making process in Black's paper would then have to be replaced by the policy rule that follows from this inherently dynamic optimization problem.

It is important for economists to better understand the differences in economic policy across different countries, just as it is important to understand the differences in a single country over time. A theory of the determination of economic policy should be able to explain both temporal and cross-sectional variation in policy. Unfortunately, we have little understanding of the factors that determine these policy differences. One reason is that the theoretically relevant definitions of policy, which include aspects of the stability of policymakers' behavior and aspects of the ability to precommit to avoid time-inconsistency issues, have not yet been successfully translated into operational terms for empirical work. Another reason is the pervasive problem of identifying true structural relationships in economics, as opposed to reduced-form relationships that do not actually represent any person's behavior and would not remain invariant to changes in other variables that may not be observed by econometricians, nor invariant to other exogenous changes in conditions. The difficulty of these problems is grounds for skepticism about the ability of economists to explain observed differences in economic policy in the near future.