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11 Short-Run Independence of Monetary Policy under a Pegged Exchange-Rates System: An Econometric Approach

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The extent to which a pegged exchange-rates system undermines the independence of an open economy's monetary policy has not been satisfactorily examined. Current empirical literature on the subject presents conclusions that are often contradictory and difficult to compare. In this paper we reevaluate the relevant empirical data and reestimate the degree of independence of monetary policy within the period of a quarter.

The literature presents three different views relevant to the independence of monetary policy under pegged exchange rates. The empirical literature on the monetary approach to the balance of payments (MABP) emphasizes the extreme situation in which the prices of goods and securities are dictated by the international market. Then the demand for money is given exogenously, and the money stock cannot be changed. Under such circumstances, monetary policy can determine only the level of international reserves. The MABP position consequently implies that no independence of monetary policy is possible. On the other hand, literature analyzing the sterilization behavior of the central bank finds that sterilization is important, suggesting that some monetary control exists.[1] Finally, the literature on capital flows argues that these flows are determined mainly by interest-rate differentials. As Z. Hodjera (1976) noted, the estimated interest-rate elasticities are small, which indicates that some independence of monetary policy is possible.

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1. The empirical study of sterilization behavior was first analyzed without any formal model by Nurske (1944) and Michaely (1971). Then reaction functions of the central banks were estimated (see Price 1978) for a survey and an empirical study of reaction functions for six main industrialized countries).

A number of authors, however, have questioned the single-equation context of these analyses. Kouri and Porter (1974) pointed out that the estimates of the interest-rate coefficient in capital-flow equations are negatively biased because of the effect, emphasized by the MABP, of capital flows on the money supply. Consequently, they estimated a "reduced-form" capital-flows equation that showed the amount of offsetting capital flows generated by a change in domestic credit and estimated this "offset coefficient." Their approach tries to synthesize the MABP literature and the capital-flows literature.[2] H. Genberg (1976), V. Argy and P. J. Kouri (1974), G. L. Murray (1978), and A. C. Stockman (1979) integrated the MABP or Kouri and Porter type of analysis with that of sterilization behavior. In their studies the reserve flow equation and the central bank reaction function are simultaneously estimated.

Unfortunately, no clear picture of the independence of monetary policy emerges from this literature.[3] There are two main reasons why: none of the authors estimate a simultaneous-equations structural model, and all treat expectations of exchange rates unsatisfactorily.[4] When variables to reflect exchange-rate expectations variables are left out of the analysis, the degree of independence of monetary policy is apt to be underestimated. The cause of this problem is downward bias in the coefficient of change in domestic credit in an MABP or Kouri-Porter type of equation in the presence of sterilization. If a structural model were estimated, however, it would appear that interest-rate elasticities of capital flows are not actually as large as the biased estimates of the offset coefficient have suggested. Because the exchange-rate expectations variables are correlated with the instruments, the use of 2SLS cannot eliminate this bias.

Recently, scholars have attempted to address these two difficulties. Herring and Marston (1977*a*) estimated a structural model of the financial sector of Germany. However, they developed such an analysis only for that country. For other European countries they used an interest-rate reduced-form equation. S. W. Kohlagen (1977), using endogenous expectations, estimated a Kouri and Porter type of capital-flow equation, also only for Germany. M. R. Darby (1980) made two separate contributions which were based on studies of seven main industrial countries. First, on a theoretical level, he emphasized the possible loss of monetary control which could occur because of some effect on exchange-rate expectations. In particular, he showed that outside some range, monetary policy can cause overwhelming capital flows. Second, he derived a

2. Other empirical studies using the same approach are Porter (1972), Kouri (1975), and Neumann (1978).

3. A detailed critical review may be found in Laskar (1981).

4. Usually authors introduce dummy variables for "speculative episodes"; Argy and Kouri (1974) take a purchasing power parity equation.

money stock equation typical of those that can be obtained from a general structural model. Using such an equation, he showed that monetary objectives do have an effect on the money stock, and hence he rejected the strict MABP hypothesis that monetary policy has no independence.

This chapter will attempt to resolve some of these issues with respect to the short-run independence of monetary policy under pegged exchange rates. To do so, we will first specify an appropriate structural model, which we will then estimate for seven industrial countries during the period of pegged exchange rates. This model will then be used to analyze the (partial) loss of monetary control due to the substitutability of domestic and foreign assets, when exchange-rate expectations are taken as given. We will then evaluate how the imperfection of knowledge about exchange-rates expectations affects the issues we have posed, consequently examining how sensitive our results may be to different treatments of exchange-rate expectations.

The model will be estimated both with and without exchange-rate expectations variables. Then, since the measurements of exchange-rate expectations we use are likely to be faulty, we will try to determine how much their inaccuracy affects the correctness of our results. Because estimates about the independence of monetary policy may be biased differently depending on whether we use the structural equations estimates, the Kouri and Porter type of equations estimates,[5] or the reduced-form money stock estimate, we will estimate all three types of equations. Finally, because estimates of sterilization behavior may be sensitive to the specification of the money supply reaction function, we will consider alternative specifications. Section 11.1 will present the model, derive three alternative estimates of independence of monetary policy, and analyze biases in these estimates when speculative variables are left out. Each of the two subsequent sections will consider one side of the issue: section 11.2 studies offsetting capital flows, and section 11.3 analyzes sterilization behavior of the central bank. Finally, section 11.4 synthesizes and presents new conclusions about the independence of monetary policy.

11.1 Presentation of the Model and Alternative Estimates of Independence of Monetary Policy

Independence of monetary policy will be taken as the possibility of the central bank's objective to affect the money supply in the short run. In this section we present our model, more precisely define and interpret what we mean by independence of monetary policy, and give three ways

5. Hodjera (1976) pointed out that, if we use OLS, the simultaneous equation biases of estimates are likely to be in opposite directions in these two kinds of equations. He also tried to compare the two approaches to capital flows but did not obtain very significant results.

of estimating the coefficient which is an indicator of such an independence.

For that, first we will present the basic structural model. The estimation of such a model will give a first estimate of our coefficient. In the next subsections we will derive two other equations. One is a semireduced-form capital-flows equation like that used in the Kouri and Porter approach. The other one is the money stock reduced form of our model. The purpose is twofold. First, we will make explicit the reasons why monetary policy may not be fully realized in an open economy. Second, we will thus obtain two other alternative estimates of our coefficient. An interesting feature of the three estimates we obtain comes from the fact that they are differently biased when exchange-rate expectation variables are left out. Therefore the last subsection analyzes these biases.

11.1.1 Basic Model

The model we are presenting contains three structural equations: a money demand equation, a capital-flows equation, and a money supply reaction function of the central bank. The money demand equation is the first difference of the short-run money demand function introduced by Chow (1966):

$$(11.1) \qquad \Delta \log\left(\frac{M}{P}\right) = a_0 + a_1\Delta r + a_2\Delta \log y + a_3\Delta \log\left(\frac{M}{P}\right)_{-1} + e_1.$$

In this equation, r is the interest rate, y is real income, M is the money stock, P is the price level, and e_1 is the residual.

Capital flows are created by the portfolio choices of residents and foreigners who consider domestic and foreign bonds as imperfect substitutes. The composition of their portfolios depends on domestic and foreign interest rates, real income, and the expected exchange-rate change. The portfolio adjustment is supposed to be completely realized within the period. Capital flows are then a function of the variation of these variables. The capital-flows variable is scaled by high-powered money,[6] and the equation is

$$(11.2) \qquad \frac{\mathrm{CF}}{H_{-1}} = b_0 + b_1\Delta r + b_1^*\Delta r^* + b_2\Delta \log y + b_2^*\Delta \log y^* + b_3\Delta(\log E - \log E^e) + e_2.$$

6. This may not be the best deflator if the portfolio choice model of a stock of assets B for residents is $B/W = f(r,r^*,y)$, where W is wealth. Some (foreign or domestic) wealth variable may have been better. But apart from the fact that these variables are difficult to introduce, the error made is probably comparatively small, because the main observed variations of CF/H_{-1} are due to variations in CF and not to variations in H_{-1}. Furthermore, as the coefficient of r_{-1} is let free in the estimation, the error may be partially corrected if the ratio of high-powered money to wealth is explained by the interest rate.

CF are capital inflows, H is high-powered money, E is the exchange rate (value of one dollar in terms of domestic currency), r^* is the world interest rate, y^* is foreign real income, and E^e is the expected exchange rate of next period. In this equation the coefficients b_1, $(-b_1^*)$ and b_3 might be seen as equal. However, due to some lack of homogeneity in the quality of data,[7] these coefficients will not be constrained. Estimates of the coefficients may also be biased differently under some specification error, such as when a speculative variable is excluded. Furthermore, in order to account for any flow effect,[8] we are eliminating constraints on the coefficients of r, r^*, and $\log E - \log E^e$ which would require that they be equal to the opposite of the coefficients of the lagged variables. The equation can thus be rewritten as

$$\text{(11.3)} \qquad \frac{CF}{H_{-1}} = b_0 + b_1 r + b_1' r_{-1} + b_1^* r^* + b_1^{*\prime} r^*_{-1} + b_2 \Delta \log y + b_2^* \Delta \log y^* + b_3(\log E - \log E^e) + b_3'(\log E - \log E^e)_{-1} + e_2 .$$

The specification for the money supply reaction function is close[9] to that used by Darby and Stockman in the Mark III Model of chapters 5 and 6. According to this specification, the money supply responds to domestic variables such as past rates of inflation, past rates of unemployment or past values of transitory real income, depending on the country, and current and past real-government-spending shocks. It also responds to balance-of-payments variables such as the current balance of payments scaled by high-powered money BP/H_{-1}, the level of reserves over high-powered money of the last period $(R/H)_{-1}$, and past changes in the balance of payments also scaled by high-powered money $(BP/H_{-1})_{-i}$, $i = 1, \ldots, k$. Because we introduce the level of reserves $(R/H)_{-1}$, we allow all the past values of the balance-of-payments variables to have an effect on the money supply. However, as the past changes of these variables $(BP/H_{-1})_{-i}$ also enter the equation, the effect of the more recent values is allowed to be different. When past values of variables

7. All rates of interest are short-term rates except the rate of Italy, which is a long-term rate. For five among the six countries, the short-term interest rates used are three-month treasury bill or money market rates. The rate of Japan is a bank-loan rate which is higher and has a much lower variance than the others.

8. If $B/W = f(r,r^*,y)$, then $dB = f(r,r^*,y)dW + W df(r,r^*,y)$. The first term gives rise to the flow effect while the second corresponds to the stock effect which was previously discussed. Also, because we are mainly interested in the estimation of the coefficients of interest rates and of $\log E - \log E^e$, and because the effect of y and y^* is probably small, the flow effect due to y and y^* is neglected in the analysis. That is the reason why only $\Delta \log y$ and $\Delta \log y^*$ enter equation (11.3).

9. The main difference between the two specifications lies in the introduction, here, of the variable $(R/H)_{-1}$, where R is the level of reserves. Thus we may account for the balance-of-payments effects for more than four quarters. Also, the deflator of the balance of payments is different: H_{-1} is used instead of nominal income. Finally, for some countries (Germany and the Netherlands), unemployment rates are used instead of real income.

enter our analysis, four lags have been taken. To reduce the number of explanatory variables, the lagged values, except for the unemployment rate or real income, have been aggregated two by two: $(x_{-1}+x_{-2})$ and $(x_{-3}+x_{-4})$. A time trend has also been introduced.[10] The resulting equation is

$$\Delta \log M = C_0 + k\frac{\text{BP}}{H_{-1}} + C_1\left(\frac{R}{H}\right)_{-1} + C_2\text{LBP1} + C_3\text{LBP3} + C_4 t + C_5\hat{g} + C_6\text{Lg1} + C_7\text{Lg3} + C_8\text{LP1} + C_9\text{LP3} + C_{10}u_{-1} + C_{11}u_{-2} + C_{12}u_{-3} + C_{13}u_{-4} + e_3, \tag{11.4}$$

where LBP1 = $(\text{BP}/H_{-1})_{-1} + (\text{BP}/H_{-1})_{-2}$ and LBP3 = LBP1_{-2}. Lg1, Lg3, LP1, LP3 are defined in the same way and correspond to government spending shocks $\hat{g}$ and rates of inflation. As in the Mark III, u is the unemployment rate, though $\log y^t$ or transitory income is substituted for u in the cases of Italy, Japan, and Canada.

The equation can also be written more completely:

$$\Delta \log M = k\frac{\text{BP}}{H_{-1}} + G_3 + e_3. \tag{11.4'}$$

In order to introduce the domestic component of the money supply in the model and define the sterilization coefficient, we consider the following two identities:

$$\Delta D + \text{BP} \equiv \Delta H, \tag{11.5}$$

$$\Delta \log H + \Delta \log \mu \equiv \Delta \log M. \tag{11.6}$$

The first identity comes from the central bank balance sheet; D is "domestic credit." The second identity defines the money multiplier μ. Then we define the variable DDM in the following way:

$$\text{DDM} \equiv \frac{\Delta D}{H_{-1}} + \Delta \log \mu. \tag{11.7}$$

With this definition of DDM, the previous identities imply that

$$\text{DDM} + \frac{\text{BP}}{H_{-1}} \equiv \Delta \log M. \tag{11.8}$$

DDM is the domestic component of the money supply growth rate. We are presuming that the monetary authorities can control DDM. In an open economy, however, they may not have a similar control of $\Delta \log M$ because they create money when they intervene in the foreign exchange market, in order to peg the exchange rate. Using (11.8), the money supply reaction function (11.4′) can also be written as

10. In the equation of France, the lagged dependent variable is also introduced.

(11.9) $$\text{DDM} = -(1-k)\frac{\text{BP}}{H_{-1}} + G_3 + e_3 .$$

The *sterilization coefficient* (c) is the coefficient of BP/H_{-1} in this equation. Therefore we have

(11.10) $$c = -(1-k).$$

If $0 \leq k \leq 1$, then $-1 \leq c \leq 0$. A strictly negative value for c indicates that the central bank has tried to get more control on the money supply by sterilizing reserve flows. If sterilization is complete ($c = -1$), full control of the money supply is realized.

The model is completed by adding the identity

(11.11) $$\text{CF} + \text{BT} \equiv \text{BP},$$

where BT is the balance of trade. The system of five equations given by the three equations of the model (11.1, 11.3, 11.4) and the two identities (11.8) and (11.11) determine the five unknowns (Δ log M, r, CF/H_{-1}, BP/H_{-1}, DDM). This means that in our model contemporaneous variables BT/H_{-1}, Δ log y, Δ log p, and (log E − log E^e) are regarded as givens. As we explained in the introduction, we are focusing on the pure substitutability of domestic and foreign assets effects and are not considering, for example, the channel which goes through exchange-rate expectations. However, in the *estimation procedure* of the model, the four contemporaneous variables (BT/H_{-1}, Δ log y, Δ log p, and (log E − log E^e)) will be considered as *endogenous*. Therefore some exogenous variables used to explain these variables more fully are added to the set of instruments. These instruments are explained in more detail in appendix 1. The three equations (11.1), (11.3), and (11.4) can be written more compactly:

(11.1′) $$\Delta \log\left(\frac{M}{P}\right) = a_1 r + a_2 \Delta \log y + G_1 + e_1 ,$$

(11.3′) $$\frac{\text{CF}}{H_{-1}} = b_1 r + b_2 \Delta \log y + b_3(\log E - \log E^e) + G_2 + e_2 ,$$

(11.4′) $$\Delta \log M = k\frac{\text{BP}}{H_{-1}} + G_3 + e_3 .$$

All the variables contained in G_1, G_2, and G_3 are exogenous in the estimation.

As we mentioned at the beginning of this section, independence of monetary policy is taken as the possibility of the central bank's objective to affect the money supply in the short run. In our model an indicator of this independence is given by the coefficient, say A, of the objective G_3 in the money stock reduced-form equation. Such an equation and the exact meaning of coefficient A are presented in detail in subsection 11.1.3 below. For the moment we can just note that coefficient A is a function of the three structural parameters a_1, b_1, and k (or c). From (11.16) below, it is equal to $-a_1/(b_1k - a_1)$. Therefore if $\hat{a}_1$, $\hat{b}_1$, and $\hat{k}$ are estimates of these coefficients, we can take $-\hat{a}_1/(\hat{b}_1\hat{k} - \hat{a}_1)$ as an estimate of A.

11.1.2 Semireduced-Form Capital-Flows Equation

We can also obtain an estimate of A by first considering a semireduced-form capital-flows equation of the Kouri and Porter type. To arrive at such an equation, we eliminate r from (11.1′) and (11.3′). Then we use identities (11.8) and (11.11) and we obtain the semireduced-form equation

$$\text{(11.12)} \quad \frac{\mathrm{CF}}{H_{-1}} = -\frac{b_1}{b_1 - a_1}\left(\mathrm{DDM} + \frac{\mathrm{BT}}{H_{-1}} - \Delta \log p\right) + \frac{b_1a_2 - a_1b_2}{b_1 - a_1}\Delta \log y - \frac{a_1}{b_1 - a_1} b_3(\log E - \log E^e) + \frac{b_1}{b_1 - a_1} G_1 - \frac{a_1}{b_1 - a_1} G_2 + \frac{b_1}{b_1 - a_1} e_1 - \frac{a_1}{b_1 - a_1} e_2.$$

Equation (11.12) is an equation of the Kouri and Porter type. The *offset coefficient* is a, where

$$\text{(1.13)} \quad a = -\frac{b_1}{b_1 - a_1}.$$

Since $a_1 \leq 0$ and $b_1 \geq 0$, then $-1 \leq a \leq 0$. Using identities (11.8) and (11.11), equation (11.12) implies

$$\text{(11.14)} \quad \Delta \log M = (1 + a)\left(\mathrm{DDM} + \frac{\mathrm{BT}}{H_{-1}}\right) - a\Delta \log p + \ldots \qquad \text{(as in (11.12))}.$$

When $a = -1$ or $a = 0$, we confront two extreme situations. The first case ($a = -1$) occurs if domestic and foreign assets are perfect substitutes, making b_1 infinite. It also occurs if money demand is insensitive to the domestic interest rate, making $a_1 = 0$. Under such circumstances, as (11.14) indicates, there is no possibility for an effective monetary policy because DDM cannot affect the money supply unless it can also affect the current variables $\Delta \log p$, $\Delta \log y$, or $(\log E - \log E^e)$. Note that BT/H_{-1} has no influence. The second case ($a = 0$) occurs when there is no substitutability between domestic and foreign assets, making $b_1 = 0$. It also occurs if there is an infinite interest elasticity of money demand, making a_1 infinite. In this situation, unless the current variables BT/H_{-1}, $\Delta \log y$, or $(\log E - \log E^e)$ are changed by DDM, we would observe a variation $\Delta \log M$ equal to DDM, without any induced capital flow. Capital flows do not depend on the current monetary policy. In that case, BT/H_{-1}, $\Delta \log y$, or $(\log E - \log E^e)$ may influence the money stock because they affect BP/H_{-1}; therefore, if sterilization of reserve flow is incomplete, $\Delta \log M$ will respond to them. Note that $\Delta \log p$ has no effect.

As shown below in subsection 11.1.3, coefficient A, our indicator of independence of monetary policy, can actually be expressed as a function of only two parameters: the offset coefficient a and the sterilization coefficient c. We have $A = (1 + a)/(1 - ac)$. Therefore, if we estimate equation (11.12) and get an estimate a, we obtain $(1 + \hat{a})/(1 - \hat{a}\hat{c})$ as a second estimate of A. In fact, the first estimate we gave in the previous subsection is equivalent to the estimate $(1 + \hat{a}^*)/(1 - \hat{a}^*\hat{c})$ where $\hat{a}^*$ is not directly estimated from (11.12) but calculated from the structural parameters estimates: $\hat{a}^* = -\hat{b}_1/(\hat{b}_1 - \hat{a}_1)$.

11.1.3 Money Stock Reduced Form

A third estimate $\hat{A}$ of coefficient A can also be obtained by directly regressing the money stock reduced-form equation. Such an equation may be obtained from (11.12), (11.4′), and the two identities (11.8) and (11.11). We get the equation

$$
\begin{aligned}
\text{(11.15)} \qquad \Delta \log M = {} & \frac{-a_1}{b_1 k - a_1} G_3 + \frac{-a_1 k}{b_1 k - a_1} \frac{\mathrm{BT}}{H_{-1}} \\
& + k \frac{b_1 a_2 - a_1 b_2}{b_1 k - a_1} \Delta \log y \\
& - \frac{a_1 k}{b_1 k - a_1} b_3 (\log E - \log E^e) \\
& + \frac{b_1 k}{b_1 k - a_1} (G_1 + \Delta \log p) + \frac{-a_1 k}{b_1 k - a_1} G_2 \\
& + \frac{b_1 k}{b_1 k - a_1} e_1 - \frac{a_1 k}{b_1 k - a_1} e_2 - \frac{a_1}{b_1 k - a_1} e_3 .
\end{aligned}
$$

We define

$$\text{(11.16)} \qquad A = \frac{-a_1}{b_1 k - a_1}.$$

We also have

$$A = \frac{1 + a}{1 - ac}.$$

If both a and c are between -1 and 0, then $0 \leq A \leq 1$. Coefficient A

decreases with $|a|$ and increases with $|c|$. We get the estimate $\hat{A}$ from the regression of (11.15) by taking the estimated coefficient of $\hat{G}_3$, where $\hat{G}_3$ is given by the estimation of the money supply reaction function.

Now we will examine why monetary objectives may not be realized. Equation (11.15) can be rewritten

$$\begin{aligned} \Delta \log M = {} & A(G_3 + e_3) \\ & + (1 - A)(G_1 + a_2\Delta \log y + \Delta \log p + e_1) \\ & + kA\left[\frac{\mathrm{BT}}{H_{-1}} + G_2 + b_2\Delta \log y \right. \\ & \left. + b_3(\log E - \log E^e) + e_2\right]. \end{aligned} \tag{11.17}$$

Now consider the case when domestic and foreign assets are perfect substitutes and the interest-rate parity relation holds:

$$r = r^* - (\log E - \log E^e). \tag{11.18}$$

Then, substituting into the money demand equation (11.1), we obtain

$$\Delta \log M = (\Delta \log M)^{\zeta},$$

where

$$\begin{aligned} (\Delta \log M)^{\zeta} = {} & \Delta \log p + a_0 + a_1\Delta r^* \\ & + a_2\Delta \log y + a_3\Delta \log \left(\frac{M}{P}\right)_{-1} \\ & - a_1\Delta(\log E - \log E^e). \end{aligned} \tag{11.19}$$

In that case the money demand is determined independently of the monetary objective, and we have the MABP version.[11] We can introduce this value $(\Delta \log M)^{\zeta}$ in the more general reduced-form money stock equation (11.17), and we get

$$\Delta \log M = A(G_3 + e_3) + (1 - A)(\Delta \log M)^{\zeta} + kA\Lambda, \tag{11.20}$$

where

$$\begin{aligned} \Lambda = {} & \frac{\mathrm{BT}}{H_{-1}} + G_2 + b_2\Delta \log y \\ & + b_3(\log E - \log E^e) + e_2 + b_1 r_{-1} \\ & + b_1\Delta r^* - b_1\Delta(\log E - \log E^e). \end{aligned} \tag{11.21}$$

11. Our term $(\Delta \log M)^{\zeta}$ is very similar to the term $\overline{\Delta \log M}$ used in Darby (1980). However, they differ in two respects. First, because we take it as given in our analysis, the domestic price level enters $(\Delta \log M)^{\zeta}$, while the foreign one enters $\overline{\Delta \log M}$. Second, the exchange-rate expectation change $\Delta(\log E - \log E^e)$ is included in $(\Delta \log M)^{\zeta}$ but not in $\overline{\Delta \log M}$. The reason is that we also take the exchange-rate expectations as given in our analysis. Furthermore, as we explained earlier, in most of the MABP literature, exchange-rate expectations are either omitted or treated in a very crude way. Therefore the term $\overline{\Delta \log M}$ may be more representative of the standard MABP literature than our $(\Delta \log M)^{\zeta}$.

The gap between the money stock realized rate of growth $\Delta \log M$ and the objective $(G_3 + e_3)$ is given by

$$\Delta \log M - (G_3 + e_3) = -(1 - A)[(G_3 + e_3) - (\Delta \log M)^{\zeta}] + kA\Lambda . \tag{11.22}$$

From this last equation, we can see two reasons why monetary objectives may not be realized. First, monetary objectives may differ from $(\Delta \log M)^{\zeta}$. Second, some variables, contained in Λ, have an effect on the balance of payments,[12] and consequently affect the money supply if sterilization is incomplete. The first effect arises because there are offsetting capital flows which are not completely sterilized: it disappears if the offsetting coefficient a is equal to zero or if sterilization is complete (in both cases $A = 1$). On the contrary, the second effect vanishes if there is complete offsetting ($a = 1$ and therefore $A = 0$), because, in that case, the variables contained in Λ actually have no effect on the balance of payments. Note, that, even if no offsetting occurs ($a = 0$ and therefore $A = 1$), the monetary objective may not be realized if sterilization is incomplete, for the second term $kA\Lambda$ may not be equal to zero. Both effects decrease and go to zero when sterilization increases and becomes complete. Here we will focus on the first effect, which is the only one related to the monetary objective itself. As mentioned, *coefficient A* defined in (11.16) will be taken as an *indicator of independence of monetary policy within the period.*

11.1.4 Biases Due to Omission of Speculative Variables

If the model is not correctly specified, these three estimates of A may be asymptotically biased, but the direction and amount of the biases will not be the same and will depend on the nature of exchange-rate expectations. Call SP $= (\log E - \log E^e)$ a speculative variable. To simplify the discussion further, suppose $b_3' = -b_3$. We can then consider the three following cases. First, we can have white noise expectations. If $\Delta \text{SP} = \epsilon$, where ϵ is white noise, a model without speculative variables would give consistent estimates. Second, we can examine "exogenous" expectations. Suppose that ΔSP is correlated with the instruments but is not a function of any of the five variables which are solutions of the model. We

12. Using the definition of G_2 and noting that, at a theoretical level, we can take $b_1 = -b_1^* = b_3$ and $b_1' = -b_1^{*\prime} = b_3'$, we obtain from (11.21)

$$\Lambda = \frac{\text{BT}}{H_{-1}} + b_0 + b_2\Delta \log y + b_2^*\Delta \log y^* + (b_1 + b_1')[r_{-1} - (r^*_{-1} - (\log E - \log E^e))]$$

The variables entering Λ are the balance of trade and variables entering the capital-flows equation: domestic and foreign real income, and the possible flow effect, which occurs if $b_1 \neq -b_1'$.

should add, however, that ΔSP may be statistically endogenous for the estimation if it is a function of BT/H_{-1}, $\Delta \log y$, or $\Delta \log p$. In this case, a model without speculative variables may not give consistent estimates, even when 2SLS are used.[13] But if this inconsistency results, then, as appendix 2 demonstrates, it is likely that the bias of $\hat{b}_1$ is negative and decreases with sterilization. Consequently, the corresponding estimate will overestimate the independence of monetary policy. On the other hand, it is also likely that the bias of $\hat{a}$ is negative and increases with sterilization. Consequently, the corresponding estimate will underestimate the independence of monetary policy. It is also likely that $\hat{A}$ will not be biased. Finally, the third case concerns "endogenous" expectations. In this situation ΔSP is a function of the variables which are solutions of the model. Take the case

$$\text{(11.23)} \qquad \begin{aligned} \text{SP} &= d_0 + d_1 \frac{\text{BP}}{H_{-1}}, \qquad d_1 \geq 0, \\ &= d_0 + d_1 \frac{\text{CF}}{H_{-1}} + d_1 \frac{\text{BT}}{H_{-1}}. \end{aligned}$$

If we substitute in equation (11.3), all the coefficients of this equation are divided by $(1 - b_3 d_1)$ and the variables $(b_3 d_1(\text{BT}/H_{-1}))$ and $(-b_3 d_1(\text{BP}/H_{-1})_{-1})$ are added. The model without speculative variables can then be considered as a structural model wherein all coefficients of equation (11.3) are higher in absolute value (we suppose $0 < 1 - b_3 d_1 < 1$), and where the variables $(b_3 d_1(\text{BT}/H_{-1}))$ and $(-b_3 d_1(\text{BP}/H_{-1})_{-1})$ are left out. Two kinds of biases will result. First, all estimates will tend to underestimate the independence of monetary policy. Second, because of the omitted variables, we will also have biases similar to those resulting from omitted exogenous variables. The two biases work in opposite directions for $\hat{b}_1$.

In order to measure exchange-rate expectations, we have taken into account the possibility that exchange-rate expectations might be endogenous and have used the balance of payments as an explanatory variable. For countries which did not devalue or revalue, the forward premium is regressed on the current balance of payments (scaled by nominal income). For countries which had a change in the value of the peg, a Tobit procedure is used in which both the probability of a change and the size of the change vary with the balance of payments. The exchange-rate expectation arrived at by the Tobit procedure is approximated by a linear

13. The problem may arise partly because we are not using an infinite sample size. Then, as in the white noise case, ΔSP may not be asymptotically correlated with the instrument set. However, for our finite sample size, there may be some correlation because the number of observations is not much larger than the number of instruments. The argument is indeed true for any residual of the system, but we consider that the variance of the capital-flows equation may be greatly increased if we leave out speculative variables.

function of both the level and the square of the value of the balance of payments (scaled by nominal income).[14]

11.2 Offsetting Capital Flows

Our model is estimated using quarterly data. Unless specified otherwise, the periods of estimation are 1957I–71II for the United Kingdom, France, Italy, and Japan; 1957I–71I for Germany and the Netherlands; and 1962III–70I for Canada. Estimation is by 2SLS. The endogenous variables are $\Delta \log M$, r, CF/H_{-1}, BP/H_{-1}, DDM, BT/H_{-1}, $\Delta \log y$, $\Delta \log p$, and $(\log E - \log E^e)$. Details on the instrument list and data are given in appendix 1.

In this section we will estimate the offset coefficient a. The two estimates presented are consistent if there are no specification errors. The first estimate is derived from the structural coefficients estimates. Using (11.13), the estimate is $-\hat{b}_1/(\hat{b}_1 - \hat{a}_1)$, where, as defined in section 1, $\hat{b}_1$ is the coefficient of the domestic rate of interest in the structural capital-flow equation and where $\hat{a}_1$ is the coefficient of the (domestic) interest rate in the money demand equation. The second estimate is obtained by regressing the semireduced-form equation (11.12) and taking the estimate $\hat{a}$ of the coefficient of the variable (DDM + (BT/H_{-1}) $- \Delta \log p$). Two alternative specifications of the model have been examined. In the first model, speculative variables are excluded while in the second model, these speculative variables are introduced in the capital-flow equations. We will present the results for the money demand equation, structural capital-flow equation, and semireduced-form capital-flow equation.

The money demand equation is presented in table 11.1.[15] In this equation, the interest-rate coefficient has the right sign and in most cases is significantly different from zero at the 5% or 10% level. The lowest t statistic occurs in the equation for Italy, maybe because it was the only country for which a long-term interest rate was used. For four countries, the absolute values of these estimates fall between 0.35 and 0.7. The estimates for Canada and the Netherlands are a little higher at 1.5. Japan stands out as an exceptional case with a coefficient close to -12. The peculiar kind of interest rate used in Japan probably accounts for this

14. In these countries numerous and important "speculative episodes" occurred. By introducing the square of the value of the balance of payments, we can reduce the weight of these observations. Therefore such exchange-rate expectations variables could also be justified even if expectations were "exogenous."

The countries which devalued or revalued are the U.K., France, Germany, and the Netherlands. These expectation functions were preliminary versions of those described in chapter 5 for the Mark III International Transmission Model. They differ, however, from the ones finally used in the estimation of the Mark III Model. One difference consists in the use in these last series of $|BP/Y|(BP/Y)$, instead of $(BP/Y)^2$, which is more correct if the sign of the balance of payments changed during the period.

15. In table 11.1, the variable $(\log E - \log E^e)_{-1}$ does not belong to the instrumental variables. When we included this variable, we obtained almost identical results.

Table 11.1 **Money Demand Equation**

	Constant	$\Delta \log \left(\frac{M}{P}\right)_{-1}$	Δr	$\Delta \log y$	S.E.E.	$\bar{R}^2$	D-W
UK	−0.001	0.069	−0.685	0.146	0.0213	0.043	2.11
	(0.003)	(0.140)	(0.530)	(0.292)			
	−0.246	0.494	−1.292	0.500			
CA	0.003	0.141	−1.462	0.231	0.0105	0.331	1.76
	(0.004)	(0.162)	(0.374)	(0.241)			
	0.891	0.873	−3.910	0.958			
FR	0.005	0.735	−0.455	−0.074	0.0122	0.536	2.04
	(0.002)	(0.091)	(0.242)	(0.103)			
	2.123	8.048	−1.879	−0.721			
GE	0.006	0.193	−0.421	0.484	0.0119	0.191	2.30
	(0.003)	(0.118)	(0.226)	(0.151)			
	1.978	1.626	−1.861	3.217			
IT	0.016	0.142	−0.355	0.372	0.0163	0.045	1.94
	(0.004)	(0.131)	(0.807)	(0.218)			
	3.521	1.085	−0.440	1.708			
JA	0.024	0.195	−12.070	−0.071	0.0171	0.321	1.74
	(0.005)	(0.144)	(3.514)	(0.210)			
	4.28	1.354	−3.435	−0.339			
NE	0.001	−0.002	−1.446	0.724	0.0173	0.136	1.96
	(0.004)	(0.138)	(0.709)	(0.232)			
	0.357	−0.013	−2.041	3.124			

Note. In all tables we give the estimate of the coefficient, its standard error (in parentheses), and the t statistic.

unusual figure. Instead of the three-month treasury bill or money market rate we used for five other countries, for Japan we used a short-term bank-loan rate. This rate is much less volatile, and consequently a small change here may be comparable to larger swings in the rates used for other countries.[16]

In this money demand equation, real income is found to be significant and of the right sign in three cases. Its elasticity is less than 1. Since the equation is run in the first difference form, we can consider that the constant is a proxy for the variation of permanent income and that therefore the coefficient of $\Delta \log y$ is a transitory income elasticity. The lagged value of the dependent variable is not significant, except in the equation for France. The overall fit is not very high, and for some countries it is low. But the regressions are in the first difference form. In levels the R^2 would have been much higher.[17]

When no speculative variables are introduced, results of the capital-flow equations are on the whole unsatisfactory. Overall fits of structural capital-flow equations are very poor for most countries. For three countries, the United Kingdom, France, and Japan, the $\hat{b}_1$ coefficients of the current interest-rate variable have the wrong sign, significantly so in the case of the United Kingdom and France, as seen in table 11.2. Consequently, for these countries, the structural estimates of the offset coefficient do not fall between -1 and 0 (see table 11.2). Also, as table 11.2 shows, there is a large difference between the structural estimates and the reduced-form estimates of the offset coefficients. While reduced-form estimates indicate an almost complete offsetting, structural estimates give a lower degree of offsetting or no offsetting at all. This result is consistent with the analysis of left out speculative variables of section 1. This emphasizes the error we can make if, in that case, we only consider one type of estimates.

16. If we multiply these values by the mean values of the interest rates during the periods of estimation, we can interpret these coefficients in terms of elasticities. We obtain -0.037 for the United Kingdom, -0.073 for Canada, -0.024 for France, -0.020 for Germany, -0.021 for Italy, -0.950 for Japan, and -0.052 for the Netherlands. The Japanese elasticity is by far the highest. However, as we mentioned (footnote 7), the standard deviation of the Japanese interest rate is the smallest (0.0038) and the mean is the largest (0.0787). Therefore the ratio (mean/standard deviation) of the Japanese interest rate is much higher than are those for any of the other countries: for Japan, this ratio is 20.7; for the other countries, the standard deviations are around 0.016, except for Italy, and the means are around 0.05, which gives a ratio of 3.1. (The variance of the Italian interest rate is smaller (0.008), and the corresponding ratio is 7.1.) Then, if we multiply the Japanese elasticity by (3.1/20.7), we obtain a value of -0.142. This interest-rate elasticity is still high in absolute value, but it is not so far afield of those of the other countries.

17. Also, in the MABP equation the $\bar{R}^2$ is quite high. This equation is actually a money demand equation, where the variable on the left-hand side is $\Delta R/H_{-1}$ and where, on the right-hand side, we have $\Delta D/H_{-1}$, $\Delta \log p$, and the money demand variables. But, as explained in Laskar (1981), the quality of the fit of this equation has no immediate interpretation.

Table 11.2 **Offset Coefficients**

	$\hat{a}_1$	$\hat{b}_1$	$\hat{b}_1^s$	$-\hat{b}_1/(\hat{b}_1-\hat{a}_1)$	$-\hat{b}_1^s/(\hat{b}_1^s-\hat{a}_1)$	$\hat{a}$	$\hat{a}^s$
UK	−0.685	−4.483	0.176	−1.180	−0.204	−0.892	−0.346
	(0.530)	(1.546)	(0.941)			(0.069)	(0.124)
	−1.292	−2.900	0.187			−12.994	−2.794
CA	−1.462	7.489	7.439	−0.837	−0.836	−0.936	−0.910
	(0.374)	(2.146)	(2.763)			(0.050)	(0.056)
	−3.910	3.489	2.692			−18.796	−16.340
FR	−0.455	−1.197	0.382	0.764	−0.456	−0.886	−0.673
	(0.242)	(0.619)	(0.419)			(0.064)	(0.082)
	−1.879	−1.933	0.913			−13.934	−8.191
GE	−0.421	3.064	3.377	−0.879	−0.889	−0.990	−0.880
	(0.226)	(1.810)	(1.246)			(0.040)	(0.051)
	−1.861	1.693	2.710			−24.585	−17.346
IT	−0.355	2.155	2.293	−0.859	−0.866	−0.635	−0.618
	(0.807)	(1.217)	(1.074)			(0.120)	(0.105)
	−0.440	1.770	2.134			−5.304	−5.866
JA	−12.070	−1.979	9.573	0.196	−0.442	−0.811	−0.518
	(3.514)	(6.341)	(3.188)			(0.114)	(0.082)
	−3.435	−0.312	3.002			−7.095	−6.292
NE	−1.446	5.560	5.151	−0.794	−0.781	−0.879	−0.782
	(0.709)	(2.294)	(1.946)			(0.067)	(0.058)
	−2.041	2.424	2.647			−13.195	−13.394

Note. The index s indicates that the coefficients are estimated in a model in which speculative variables are introduced.

The model with speculative variables is more satisfactory, and the full results are given in tables 11.3 and 11.4. Overall fits of structural capital-flow equations are improved. Most interest-rate coefficients have the right sign. All coefficients of the current interest rate are positive,[18] and except those of the United Kingdom and France, they are all significant. In the case of four countries, the United Kingdom, France, Germany, and Japan, the current speculative variable enters significantly and with the right sign. For the other countries the speculative variables do not enter in a meaningful way and, especially for the Netherlands, they even enter significantly with the wrong sign. For this last country the expectation variable we take may be inadequate. However, for these three countries results were quite satisfactory in the model without speculative variables, as table 11.2 indicates. Actually, these results are not much changed when we add our speculative variables, which, as noted, do not enter in a meaningful way. Finally, note that for most countries the coefficient of the current interest-rate variable has a higher absolute value than the coefficient of the lagged variable, which suggests that a flow effect exists.

The semireduced-form capital-flow equations are presented in table 11.4. As can be seen, the absolute values of the offset coefficient are lower than those obtained in the model without speculative variables. The difference is quite large for the U.K.: 0.346 instead of 0.892. For each country except Canada, the offset coefficient is significantly different from -1, at the 5% level. The pattern of the speculative variables coefficients is the same as that of the structural equation, but, as expected, they are smaller because in equation (11.12) they are multiplied by $(-a_1/(b_1 - a_1))$.

A comparison of the offset coefficients obtained can be seen in table 11.2. When the speculative variables are added, all coefficients $\hat{b}_1$ are positive. Therefore the corresponding offset coefficients have values between (-1) and 0 (see column 5). For all countries except Italy and Germany, these offset coefficients $(-(\hat{b}_1^s/(\hat{b}_1^s - \hat{a}_1)))$ are still lower than the ones we get from the semireduced form $(\hat{\alpha}^s)$. However, the difference between them is not large. Especially in the cases of the four countries for which the speculative variables entered significantly, the United Kingdom, France, Germany, and Japan, the difference is actually much smaller than the one we observed in the model without speculative variables. There are two reasons for this finding. First, the coefficients $\hat{b}_1$

18. In the interpretation of the magnitude of the domestic interest-rate coefficients of the equation of Japan, we should have in mind the peculiar rate of interest used for this country (see footnote 16 above). The value of the coefficient of r is large (9.5), but, in fact, the implied capital mobility may not be high: if we try to "correct" this value, multiplying it by the ratio of the standard deviation of the Japanese interest rate divided by the standard deviation of the other countries' interest rates (0.0038/0.016) (see footnote 16 above), then we obtain a value of 2.26.

are higher, especially for Japan and the United Kingdom. Consequently, a greater amount of offsetting is implied. Second, the offset coefficients estimated from the semireduced form are smaller in absolute value for all countries but more importantly for these four countries. Again, these results are consistent with the analysis of biases due to speculative variables of section 11.1.

The estimates of the offset coefficients we obtain indicate that capital flows do not completely offset any change in the domestic component of the money supply. Actually, using the reduced-form estimates, the hypothesis of complete offsetting is rejected at the 5% level for six of the countries and at the 10% level for Canada. The highest offset coefficients in absolute value are those for Canada and Germany, which are around −0.9. The coefficient of the Netherlands is also high in absolute value, around −0.8. The offset coefficient for France is between −0.67 and −0.45, for Japan between −0.50 and −0.40. The offset coefficient of the United Kingdom seems comparatively quite low in absolute value, between −0.35 and −0.20.[19] Italy presents a special case. The offset coefficient calculated from the structural estimates is lower than the estimate given by the semireduced form, even in the model without speculative variables. The values are −0.86 and −0.63, respectively. The use of a long-term interest rate may have caused this peculiar finding. We can note that these intercountry differences make sense because France and Japan seemed to rely more on capital controls than Canada or Germany did.

Even if the offset coefficients are different from −1, their absolute values may still be thought to be "high," especially for some countries. However, a value of the offset coefficient which is not equal to zero actually means that some monetary policy has a cost in terms of undesired reserves. Therefore, in order to interpret the magnitude of the offset coefficient, we should consider this cost. To illustrate the point, suppose that we start from an equilibrium situation where all countries have the same rate of inflation as the U.S., say 6%. Now suppose that one of these countries wants to decrease its inflation rate to 4%. If the offset coefficient of this country is equal to −0.5, which may be the case for France or Japan, then there would be an implied gain of reserves equal to 0.5% of high-powered money within the quarter.[20] However, if the offset

19. However, the coefficient of the U.S. interest-rate variables in the structural capital-flow equation might suggest a higher absolute value for the offset coefficient of the U.K. The coefficients of r^{US} and r^{US}_{-1} are −1.56 and 1.65, respectively. They are both significantly different from 0 at the 5% level. If we take a value of 1.6 for $\hat{b}_1$ (this may be justified because the U.K. and U.S. interest rates used are quite homogenous in their definitions), then the implied offset coefficient is −0.70. I do not see an explanation of the discrepancy between this value and the other lower values found.

20. From (11.14) the variation in domestic credit required to produce a variation δ in the money supply growth rate is equal to $\delta/(1 + a)$. Therefore the variation in reserves is equal to $[a/(1 + a)]\delta$. Here $\delta = \pm 0.5\%$ ($\pm 2\%$ at an annual rate).

Table 11.3 Structural Capital-Flow Equation (Speculative Variables Added)

	UK	CA	FR	GE	IT	JA	NE
Coefficients							
Constant	.081	.129	−.010	−.046	−.017	−.003	−.010
	(.017)	(.046)	(.009)	(.026)	(.026)	(.089)	(.023)
	4.72	2.830	−1.073	−1.722	−.669	−.031	−.421
r	.176	7.439	.382	3.377	2.293	9.573	5.151
	(.941)	(2.763)	(.419)	(1.246)	(1.074)	(3.188)	(1.946)
	.187	2.692	.913	2.710	2.134	3.002	2.647
r_{-1}	.037	−2.979	−.046	−1.204	−1.119	−9.341	−3.226
	(.697)	(2.136)	(.374)	(1.050)	(1.083)	(3.313)	(1.757)
	.053	−1.395	−.122	−1.147	−1.033	−2.820	−1.836
r^{US}	−1.557	−7.689	−.001	−5.118	−.789	−.355	−3.757
	(.688)	(3.163)	(.496)	(1.538)	(.537)	(.459)	(1.243)
	−2.263	−2.004	−.002	−3.328	−1.468	−.772	−3.024
$r^{US}-1$	1.652	1.843	.351	2.833	−.629	−.363	3.219
	(.771)	(3.163)	(.541)	(1.626)	(.535)	(.448)	(1.294)
	2.143	.583	.650	1.742	−1.175	−.810	2.487

$\Delta \log y$	.162	1.088	−.333	.276	−.196	.131	−.729
	(.323)	(1.189)	(.222)	(.637)	(.255)	(.208)	(.654)
	.502	.916	−1.499	.432	−.768	.629	−1.115
$\Delta \log y^R$	.694	−3.697	.134	2.185	−.415	−.044	1.377
	(.492)	(1.922)	(.379)	(1.064)	(.379)	(.360)	(.944)
	1.409	−1.923	.354	2.054	1.094	−.122	1.459
$4(\log E - \log E^e)$	10.850	−.659	.683	2.227	−.634	4.203	−17.864
	(1.269)	(.703)	(.127)	(.565)	(.227)	(.449)	(4.941)
	8.550	−.938	5.386	3.939	−2.790	9.536	−3.615
$4(\log E_{-1} - \log E^e_{-1})$	1.019	.126	.036	−1.791	−.254	−.221	3.718
	(1.131)	(.777)	(.090)	(.417)	(.206)	(.441)	(4.308)
	.901	.163	.406	−4.292	−1.232	−.500	.863
S.E.E.	.0228	.0435	.0167	.0470	.0172	.0155	.0377
$\bar{R}^2$	.843	.289	.650	.550	.587	.795	.499
D-W	1.65	1.39	1.47	1.87	1.92	1.45	1.45

Table 11.4 Semireduced-Form Capital-Flow Equation (Speculative Variables Added)

	UK	CA	FR	GE	IT	JA	NE
Coefficient							
Constant	.060	.013	.001	.014	.017	−.009	.016
	(.015)	(.016)	(.007)	(.009)	(.021)	(.065)	(.009)
	4.015	.779	.141	1.691	.837	−.131	1.824
$DDM + BT/H_{-1} - \Delta \log P$	−.346	−.910	−.673	−.880	−.618	−.518	−.782
	(.124)	(.056)	(.082)	(.051)	(.105)	(.082)	(.058)
	−2.794	−16.340	−8.191	−17.346	−5.866	−6.292	−13.394
$\Delta \log\left(\frac{M}{P}\right)_{-1}$	−.057	.042	.404	−.045	.015	.155	−.128
	(.134)	(.216)	(.114)	(.171)	(.119)	(.090)	(.115)
	−.428	.194	3.558	−.264	.124	1.711	−1.112
r_{-1}	−.176	.491	.022	−.045	.134	.299	.424
	(.323)	(.464)	(.136)	(.170)	(.345)	(.726)	(.230)
	−.546	1.059	.162	−.266	.389	.411	1.843
r^{US}	−.828	−1.269	−.201	−.521	−.192	−.274	−.061
	(.574)	(.634)	(.283)	(.407)	(.381)	(.334)	(.431)
	−1.442	−2.004	−.710	−1.281	−.503	−.819	−.119

r^{US}_{-1}	1.122	.593	.339	.319	−.136	−.034	−.082
	(.596)	(.749)	(.307)	(.444)	(.425)	(.325)	(.507)
	1.881	.792	1.106	.719	−.320	−.104	−.161
$\Delta \log y$	.124	−.040	−.134	.486	.186	−.013	.502
	(.237)	(.325)	(.129)	(.171)	(.200)	(.157)	(.257)
	.521	−.123	−1.043	2.840	.929	−.086	1.952
$\Delta \log yR$	.612	.399	.483	.122	−.047	−.108	.017
	(.357)	(.608)	(.219)	(.298)	(.283)	(.254)	(.364)
	1.716	.655	2.205	.422	−.167	−.423	.048
$4(\log E -$	7.153	−.285	.198	.597	−.478	2.353	−7.079
$\log E^e)$	(1.604)	(.187)	(.089)	(.195)	(.173)	(.416)	(1.997)
	4.458	−1.519	2.220	3.068	−2.755	5.661	−3.545
$4(\log E_{-1} -$	.724	−.103	.075	−.367	−.246	.110	−.890
$\log E^e_{-1})$	(.723)	(.186)	(.051)	(.127)	(.154)	(.343)	(1.997)
	1.002	−.556	1.467	−2.895	−1.596	.322	−.542
S.E.E.	.0170	.0115	.0095	.0125	.0127	.0112	.0135
$\bar{R}^2$	.913	.950	.887	.968	.774	.892	.935
D-W	1.85	1.60	1.86	2.07	2.10	1.67	2.13

coefficient were equal to -0.9, as in Canada or Germany, then the gain in reserves would be equal to 4.5% of high-powered money. We would have the opposite loss of reserves if the desired inflation rate were equal to 8%. These illustrative numbers may explain why countries like France, Japan, and the United Kingdom were able to have inflation rates which were different from that of the U.S., while Canada and Germany seemed to have inflation rates similar to that of the U.S. However, in order to be able to interpret what happened, we must also take into account the weight the central banks attribute to undesired losses or gains of reserves. Sterilization behavior takes this aspect into account.

11.3 Sterilization Behavior

In this section we focus on the estimation of the sterilization coefficient. As defined in section 11.1, equation (11.10), the sterilization coefficient is $c = -(1-k)$, where k is the coefficient of the current balance-of-payments variable BP/H_{-1} in the money supply reaction function. Here we will estimate the money supply reaction function (11.4) and then briefly consider alternative specifications.

The estimates[21] of the coefficients of the balance-of-payments variables of the money supply reaction function are given in table 11.5. Contemporaneous sterilization is high for all countries, and the hypothesis of no sterilization is always rejected at the 5% level. All the sterilization coefficients are close to -1 and only in two cases, Germany and the Netherlands, does money supply respond to the current balance-of-payments variable BP/H_{-1} in a significant way. But even in these cases, almost 90% of the effect of the balance of payments on the money supply is sterilized.[22]

Money supply seems to respond more significantly to past changes of the balance of payments. The coefficient of the level of reserves over high-powered money of the last quarter $(R/H)_{-1}$ is positive for all countries except France, where it is negative but not significant. For Italy, Japan, and the Netherlands, this positive response is significant at the 5% level. The value of the coefficient is around 0.1 for Italy and the Netherlands and 0.2 for Japan. Individual coefficients of the lagged balance-of-payments variables are not significantly different from zero at the 5% level except the coefficient of the lagged variable by 3 or 4 in the German equation. At a lower level of significance (20%), these variables produce a positive effect in the equations for France and the United Kingdom, and

21. Here, the instruments used for the 2SLS estimation contain the lagged speculative variable $(\log E - \log E^e)_{-1}$.

22. For Canada, France, and Italy the estimates indicate a slight oversterilization, which may be unlikely; the sterilization coefficient is, however, not significantly different from -1.

Table 11.5 **Money Supply Reaction Function Equation (Coefficients of Balance-of-Payments Variables Only)**
Dependent Variable = $\Delta \log M$

	BP/H_{-1}	$(R/H)_{-1}$	LBP1	LBP3	S.E.E.	$\bar{R}^2$	D-W
UK	0.040	0.079	0.018	0.038	0.0161	0.180	2.07
	(0.062)	(0.073)	(0.027)	(0.023)			
	0.650	1.082	0.681	1.628			
CA	−0.103	−0.0233	0.077	0.013	0.0131	−0.063	2.58
	(0.207)	(0.125)	(0.045)	(0.052)			
	−0.500	−0.187	1.704	0.252			
FR	−0.014	0.015	0.057	0.005	0.0086	0.599	1.99
	(0.080)	(0.030)	(0.037)	(0.044)			
	−0.179	0.494	1.547	0.116			
GE	0.113	0.033	−0.004	0.054	0.0077	0.565	2.14
	(0.030)	(0.023)	(0.015)	(0.019)			
	3.758	1.422	−0.290	2.781			
IT	−0.234	0.093	0.099	−0.052	0.0141	0.038	1.95
	(0.205)	(0.045)	(0.100)	(0.093)			
	−1.137	2.063	0.984	−0.555			
JA	0.127	0.196	−0.019	0.008	0.0129	0.588	1.72
	(0.098)	(0.066)	(0.065)	(0.050)			
	1.294	2.957	−0.295	0.159			
NE	0.152	0.106	−0.060	−0.054	0.0118	0.297	2.60
	(0.063)	(0.039)	(0.034)	(0.040)			
	2.404	2.685	−1.753	−1.753			

a negative effect for the Netherlands. The fits of the equations for Canada and Italy are very poor, and that for the United Kingdom is also quite poor. Other equations show a better fit.

The sterilization coefficient may be sensitive to alternative specifications of the reaction function, especially when these alternative specifications concern the balance-of-payments variables. Therefore we experimented with a variety of such reaction function specifications.[23] The results indicate that we have to modify our previous findings for three countries: Japan, Italy, and the Netherlands. The corresponding reaction functions are given in table 11.6. For Japan, the distinction between surpluses and deficits is found to be relevant. For Italy and the Netherlands, the current and lagged balance-of-trade variables are substituted for the lagged balance-of-payments variables.

Clearly, contemporaneous sterilization of reserve flows exists and is important in all the countries studied. However, the behavior of each country is different. In the United Kingdom, Canada, and France, sterilization appears to be complete. The hypothesis of full sterilization is not rejected, and the estimates of the sterilization coefficient are very close to -1. In Germany, 89% of reserve flows are sterilized. In Japan, sterilization behavior toward deficits is not the same as toward surpluses. Only 50% of deficits are sterilized while sterilization of surpluses is complete. For the Netherlands, several specifications are acceptable. However, the values of the estimates are not the same in these alternative specifications. The values found for this coefficient range from -0.85 to -0.95. Although most specifications indicate that Italy's reserve flows are completely sterilized, the best fit obtained shows that only 66% of them are sterilized. Although the estimate is somewhat imprecise, it allows us to reject the hypothesis of full sterilization at the 10% level.

11.4 Independence of Monetary Policy

In this section, we present estimates of coefficient A, which was defined in section 11.1, equation (11.16). This coefficient is regarded as an

23. The results of these experimentations are presented in detail in Laskar (1981). One of the findings is that three countries, the United Kingdom, Canada, and France, let their money supply respond to speculative capital flows, while they completely sterilized the other components of the balance of payments. Note that this finding eliminates some inconsistencies in our results. Otherwise, the complete sterilization of reserve flows in France, and almost complete one in the United Kingdom, that we found in this section would have been inconsistent with the findings of section 11.3. There, we found that left-out speculative variables produced a negative bias in the estimates $\hat{b}_1$. But, theoretically, at least under the assumptions explicated in appendix 2, such a bias cannot exist if sterilization is complete. Finally, we note that sterilization of speculative capital flows is irrelevant for the issue of independence of monetary policy considered here, because we take exchange-rate expectations as given in the analysis.

Table 11.6 Other Specifications of the Reaction Function: Equations of Japan, Italy, and the Netherlands

a) Equations of Japan

1) $\left(\frac{BP}{H_{-1}}\right)^{-}$ added $\left(\frac{BP}{H_{-1}}\right)^{-} = \frac{BP}{H_{-1}}$ if $\frac{BP}{H_{-1}} < 0$ and 0 otherwise

$\left(\frac{BP}{H_{-1}}\right)^{-}$	$\frac{BP}{H_{-1}}$	$\left(\frac{R}{H}\right)_{-1}$	LBP1	LBP3
0.767	−0.159	0.363	−0.072	−0.033
(0.240)	(0.128)	(0.081)	(0.063)	(0.048)
3.193	−1.243	4.494	−1.144	−0.689

S.E.E. = 0.0120 $\bar{R}^2 = 0.644$ D-W = 248

2) $\left(\frac{BP}{H_{-1}}\right)^{-}$ and lagged values LBPM1 and LBPM3 added (LBPM1 = $\left(\frac{BP}{H_{-1}}\right)^{-}_{-1} + \left(\frac{BP}{H_{-1}}\right)^{-}_{-2}$)

$\left(\frac{BP}{H_{-1}}\right)^{-}$	$\frac{BP}{H_{-1}}$	$\left(\frac{R}{H}\right)_{-1}$	LBPM1	LBPM3	LBP1	LBP3
0.447	−0.021	0.310	0.020	0.139	−0.055	−0.100
(0.174)	(0.106)	(0.068)	(0.103)	(0.107)	(0.085)	(0.077)
2.577	−0.200	4.566	0.199	1.298	−0.644	−1.292

S.E.E. = 0.0117 $\bar{R}^2 = 0.665$ D-W = 2.35
(OLS estimates)

b) Equations of Italy and the Netherlands

	$\frac{BP}{H_{-1}}$	$\frac{R}{H_{-1}}$	$\frac{BT}{H_{-1}}$	LBT1	LBT3	S.E.E.	$\bar{R}^2$	D-W
IT	0.344	0.018	−0.102	−0.072	0.302	0.0119	0.311	2.06
	(0.192)	(0.038)	(0.208)	(0.116)	(0.104)			
	1.795	0.472	−0.493	−0.623	2.908			
NE	0.045	0.025	0.167	−0.051	0.017	0.0106	0.439	2.40
	(0.050)	(0.033)	(0.079)	(0.035)	(0.035)			
	0.896	0.742	2.119	−1.459	0.488			

indicator of the independence of monetary policy within the period. Its value should be between 0 and 1. A value equal to 0 indicates that no independence of monetary policy exists, while complete independence is obtained when its value is equal to 1. From equation (11.16), we have $A = (1 + a)/(1 - ac)$. Therefore, with the results obtained in the previous two chapters, we can give estimates of this coefficient. Alternatively, we can also regress the money stock reduced-form equation (11.15) and take the estimated coefficient $\hat{A}$ of the variable $\hat{G}_3$, the estimated objective of monetary policy obtained from the regression of the money supply reaction function.[24] The results obtained when the standard specification of the model is used appear in table 11.7. We consider both cases in which speculative variables are introduced and cases in which they are added to the model.[25]

The results found for the estimates $\hat{A}$ show the existence of a large degree of independence in monetary policy. At the 5% level, all coefficients are significantly different from zero and none is significantly different from 1. We can compare the estimates $\hat{A}$ with the estimates of the first two columns. According to our findings about the biases caused by omitted speculative variables, values in columns 1 and 2 are likely to be higher and lower, respectively, than the values of column 3, especially in the model without speculative variables. In the model with speculative variables the three estimates should be close.[26] This is verified in the cases of the United Kingdom, Canada, France, and Japan. For the first three countries, the estimates $\hat{A}$ are close to 1, which is consistent with the results of complete sterilization found for these countries.[27] For Japan, all these estimates in the model with speculative variables indicate a value of 0.9 for coefficient A. However, we do not find the expected pattern for these three estimates in the other three countries. In the case of Italy, the estimated coefficient $\hat{A}$ has a value around 0.7, although in the standard specification sterilization is estimated to be complete. For the Netherlands and Germany, the $\hat{A}$ estimates are higher than the other two estimates.

It is important to evaluate how the results obtained from other specifications of the reaction function in section 11.3 modify our previous findings. Then, for Italy and the Netherlands, we find estimates which are not far from the values of the estimates of $\hat{A}$.[28] For Italy, if we use the

24. This regression bears some resemblance to the one considered by Darby (1980). But some differences exist. First, we can take the domestic price as given; second, we specify an alternative model. Therefore we add the "other factors" which "also play a role in determining the balance of payments" (p. 6) under the alternative model considered here. Darby's purpose was to see whether he could reject the null hypothesis of no independence of monetary policy implied by the MABP rather than to estimate a coefficient which would measure this independence.

25. According to the previous findings, the model with speculative variables should give more correct results for the United Kingdom, France, Germany, and Japan, while the model without speculative variables may give satisfactory results for Canada and the Netherlands. For Italy, no model seems to work really well.

26. These statements assume that there are no other specification errors than left-out speculative variables. Therefore these statements may not be verified if the money supply reaction function is incorrectly specified.

27. For the United Kingdom the estimated coefficient $\hat{c}$ is slightly less than 1 in absolute value (-0.96). Also, we saw in section 11.2, footnote 19, that in the model with a speculative variable the offset coefficient may be higher in absolute value (-0.7) than the one given by $\hat{b}_1/(\hat{a}_1 - \hat{b}_1)$ or $\hat{a}$. Taking the same sterilization coefficient as before (-0.96), the implied value for A is 0.91, which is still high.

28. However, if that new specification is correct, the values of A in the tables may not be good estimators because $\hat{G}_3$ is not the same.

Table 11.7 **Estimates of the Independence of Monetary Policy**

	Model without Speculative Variable			Model with Speculative Variable		
	Structural Estimate (1)	Semireduced-Form Estimate (2)	$\hat{A}$ (3)	Structural Estimate (1)	Semireduced-Form Estimate (2)	$\hat{A}$ (3)
UK	1	0.752	0.946 (0.192) 4.920	0.990	0.979	1.040 (0.227) 4.591
CA	1	1	0.983 (0.368) 2.671	1	1	1.083 (0.381) 2.843
FR	1	1	0.984 (0.298) 3.303	1	1	1.405 (0.351) 4.001
GE	0.549	0.082	0.760 (0.217) 3.503	0.525	0.547	0.920 (0.193) 4.771
IT	1	1	0.720 (0.187) 3.857	1	1	0.666 (0.255) 2.610
JA	1	0.647	0.876 (0.213) 4.103	0.909	0.880	0.890 (0.214) 4.162
NE	0.631	0.475	0.879 (0.217) 0.043	0.648	0.647	0.987 (0.221) 4.476

Note. A value equal to 1 has been put in columns 1 and 2 whenever the sterilization coefficient is more than 1 in absolute value or when coefficient $\hat{b}_1$ is negative. Then full independence of monetary policy is obtained because either sterilization is complete or offsetting capital flows do not exist.

estimate $\hat{c}$, which is equal to -0.656, given by the improved specification, we obtain other estimates of A in columns 1 and 2 of the tables. In the model with speculative variables these values are 0.310 and 0.642, respectively. Therefore, in Italy, the independence of monetary policy may not be vary large, although the results are imprecise and questionable. For the Netherlands, the higher degree of sterilization given by the estimate of table 11.6 ($\hat{c} = -0.955$) implies an estimate of A equal to 0.85 (for that we use an offset coefficient equal to -0.8, given by the empirical analysis of section 11.2). From this value we can conclude that even in a small open economy like the Netherlands, monetary policy may have a large independence. Finally, we found that the money supply of Japan does not respond to surpluses but strongly reacts to deficits. Consequently, we have to distinguish between an expansionary and a restrictive monetary policy. The objective of a restrictive policy is realized but not that of an expansionary policy. With an offsetting coefficient[29] equal to -0.45 and a sterilization coefficient of deficits equal to -0.5, the estimated value for A is 0.71.

The estimates show that a high degree of independence exists in monetary policy during the quarter. With the exception of Italy, where the imprecisions in the estimates of both the offset coefficient and the sterilization coefficient allow a range from 30% to 100%, the countries realize at least 50% of their objectives. In Canada, France, and the United Kingdom, more than 90% of control is obtained. In the Netherlands, from 65% to 85% of the objectives are realized. In Germany, the situation is less clear. Although the offset coefficient and the sterilization coefficient estimates indicate that a control of only 50% exists, the money stock reduced-form estimate suggests a control of 90%. In Japan, on the "average," 90% of the objectives are realized, but, while a restrictive policy may be completely under control, only 70% of an expansionary one may be controlled. The main reasons for these findings are that the almost complete sterilization of reserve flows implies an almost full control for Canada, France, and the United Kingdom. The importance of offsetting capital flows explains the possible comparatively low independence found for Germany.[30] The high "average" degree of independence of Japan is explained by the small amount of offsetting capital flows. Although the estimates concerning the independence of an expansionary

29. However, if such a large difference in sterilization behavior exists, another difference in capital controls might also exist. Consequently the offset coefficient for an expansionary monetary policy might be lower and therefore the independence of an expansionary monetary policy might be higher than the value we give here.

30. In their study of Germany, Herring and Marston (1977*a*, *b*) found an offset coefficient equal to -0.78 and a sterilization coefficient equal to -0.913. The implied value for coefficient A is 0.746. There are no differences between their results and ours concerning the estimates of the sterilization coefficient: the value they find is close to the one we take (-0.868) for the estimation of A. However, our estimate of the offset coefficient (-0.88) has a greater absolute value.

monetary policy for the Netherlands and Japan are both around 70%, the two countries are actually very different. In the case of the Netherlands, both offsetting capital flows and sterilization are important. For Japan, both are low.

Our analysis indicates that the substitutability of domestic and foreign assets has not been an insurmountable obstacle to the central banks of the countries we studied. This possibility of short-run independence may explain why inflation rates differed among countries. In that respect most intercountry differences we found make sense. For as we already mentioned in section 11.2, Germany had an inflation rate more like that of the U.S. than France, the U.K., or Japan had. Also, the Netherlands seemed to differ more from the U.S. than Germany did. On the other hand, however, the result of the almost complete independence we obtained for Canada does not seem to be reflected in its observed rate of inflation, because this country had a similar experience to the one of the U.S. Several explanations may account for this discrepancy. First, we must keep in mind the partial and short-run nature of our analysis. Second, the Canadian reaction function is the least satisfactory one we found. It has a negative $\bar{R}^2$ in the standard specification. Therefore the result of complete sterilization may appear doubtful. As the offset coefficient has a high absolute value, the highest one with Germany, even a small response of the money supply to the balance of payments may considerably decrease the independence of monetary policy. Third, relative inflation rates between countries also depend on the monetary objectives of these countries. Because of some other similarities, the monetary objective of Canada may be close to the one of the U.S.

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Appendix 1

Instrument List and Data

Instrument List

The instrument set contains all the exogenous variables of the model and some variables used to explain $\log y$, $\log p$, and BT/H_{-1}, which are treated as endogenous variables for the estimation. These variables are

$$\log y_{-1},\ \hat{M}_{-1},\ \Delta \log p^{\mathrm{US}},\ \Delta \log p_{-1},$$
$$\left(\frac{X}{Y}\right)_{-1},\ \left(\frac{I}{Y}\right)_{-1},\ \log\left(\frac{P_I}{P}\right)_{-1},$$

where $\hat{M}$ is a money innovation $\log M - \log M^e$, X exports, I imports, P_I the import price, and Y nominal income. For five countries, when no speculative variable is included, we have twenty-six variables in the instrument set. For France, we have two more variables: the lagged money stock $\Delta \log M_{-1}$, which is added to the reaction function; and a dummy for 1968II, because of May–June 1968 events. In fact, this last variable never entered significantly in the model. Canada is apart: because of the small number of observations (thirty-five), the balance of trade is treated as exogenous and then the number of instruments is equal to twenty-four. This is actually still high; therefore, for this country, the 2SLS estimates may indeed not be very satisfactory. In the model with speculative variables, one variable, $(\log E - \log E^e)_{-1}$, is added to the instrument list.

Data

The foreign interest rate is the U.S. three-month treasury bill interest rate. The foreign real income is a nominal income weighted average of other countries' real income. In this calculation the U.S. is added to the set of countries considered here. The balance-of-payments definition is the official settlement one. The variation of domestic credit ΔD is defined as $\Delta D = \Delta H - \mathrm{BP}$. Capital flows are defined as $\mathrm{CF} = \mathrm{BP} - \mathrm{BT}$. The money stock is M_1 for the United Kingdom, Canada, Italy, and Japan, and M_2 for France, Germany, and the Netherlands. All data come from the files of the Mark III Model described in chapter 6 or from the basic data bank described in the Data Appendix.

Appendix 2

Biases in Case of Left-out "Exogenous" Speculative Variables

Since we suppose $b_3' = -b_3$, suppose also $b_1' = -b_1$. Then, define G_1' and G_2' such that

$$G_2 = G_2' - b_3\mathrm{SP}_{-1} - b_1 r_{-1},$$
$$G_1 = G_1' - a_1 r_{-1}.$$

Therefore

$$G_1' = a_0 + a_3\Delta \log\left(\frac{M}{P}\right)_{-1},$$

$$G_2' = b_0 + b_1^* r^* + b_1^{*\prime} r_{-1}^* + b_2\Delta \log y + b_2^*\Delta \log y^*.$$

Then (11.1) can be written

$$\Delta \log\left(\frac{M}{P}\right) = a_1\Delta r + a_2\Delta \log y + G_1' + e_1. \quad (11.24)$$

As we assumed here that $b_1 = -b_1'$ and $b_3 = -b_3'$, equation (11.3) can be written

$$\frac{\text{CF}}{H_{-1}} = b_1\Delta r + b_2\Delta \log y + b_2\Delta\text{SP} + G_2' + e_2. \quad (11.25)$$

Then, eliminating Δr, we obtain the same semireduced-form capital-flows equations as (11.12), where, however, ΔSP is substituted for ($\log E - \log E^e$), and where G_1' and G_2' have replaced G_1 and G_2, respectively. Then, using the definition of a, we can write

$$\frac{\text{CF}}{H_{-1}} = a\left(\text{DDM} + \frac{\text{BT}}{H_{-1}} - \Delta \log p\right) + \alpha\Delta \log y + (1+a)b_3\Delta\text{SP} - aG_1' + (1+a)G_2' + v_1. \quad (11.26)$$

where $\alpha = (b_1a_2 - a_1b_2)/(b_1 - a_1)$ and v_1 is a residual.

Now suppose that, although correlated with the instrument set, ΔSP is not correlated with G_1', G_2', or $\Delta \log y$. Then the direction of the 2SLS asymptotic biases of $\hat{b}_1$ when we estimate the structural capital-flows equation and the direction of $\hat{a}$ when we estimate the semireduced-form one are given by $\text{cov}((\Delta r)^\psi, b_3\Delta\text{SP})$ and $\text{cov}((\text{DDM})^\psi + (\text{BT}/H_{-1})^\psi) - (\Delta \log p)^\psi, (1+a)b_3\Delta\text{SP})$, respectively ($\text{cov}(x,y)$ denotes the covariance of the variables x and y, and $(x)^\psi$ denotes the projection on the instrument set). We can compute these covariances from the reduced forms for Δr and DDM. To obtain the reduced form for Δr, first invert the money demand equation (11.24):

$$\Delta r = \frac{1}{a_1}\Delta \log M - \frac{1}{a_1}\Delta \log p - \frac{a_2}{a_1}\Delta \log y - \frac{G_1'}{a_1} - \frac{e_1}{a_1}. \quad (11.27)$$

Then substitute the reduced form for $\Delta \log M$, which is given by equation (11.15). Again, under the assumptions considered here, this equation can be written with ΔSP, G_1', and G_2' substituted for ($\log E - \log E^e$), G_1 and G_2, respectively. This gives

(11.28)
$$\Delta r = \frac{-1}{b_1 k - a_1} G_3 - \frac{k}{b_1 k - a_1} \frac{\text{BT}}{H_{-1}} + \frac{a_2 - k b_2}{b_1 k - a_1} \Delta \log y - \frac{k}{b_1 k - a_1} b_3 \Delta \text{SP} + \frac{1}{b_1 k - a_1} (G_1' + \Delta \log p) - \frac{k}{b_1 k - a_1} G_2 + w_1 ,$$

where w_1 is a residual. In order to find the reduced form for DDM, write the money supply reaction function under the form

(11.29)
$$\text{DDM} = c \frac{\text{CF}}{H_{-1}} + c \frac{\text{BT}}{H_{-1}} + G_3 + e_3 .$$

Then consider {(11.26), (11.29)} and, eliminating CF/H_{-1}, solve for DDM:

(11.30)
$$\text{DDM} = \frac{a(1+c)}{1-ac} \frac{\text{BT}}{H_{-1}} + \frac{1}{1-ac} G_3 - \frac{ac}{1-ac} \Delta \log p + \frac{\alpha c}{1-ac} \Delta \log y + \frac{(1+a)c}{1-ac} b_3 \Delta \text{SP} - \frac{ac}{1-ac} G_1' + \frac{(1+a)c}{1-ac} G_2' + w_2 .$$

Now, if we consider the special case where ΔSP is not correlated with BT/H_{-1}, $\Delta \log p$ and G_3, then we have, from (11.28):

(11.31)
$$\text{cov}\left((\Delta r)^{\psi}, b_3 \Delta \text{SP}\right) = - \frac{k}{b_1 k - a_1} \text{var}\left(b_3 (\Delta SP)^{\psi}\right).$$

This is negative and is equal to 0 if $k = 0$ (complete sterilization). The coefficient of the interest rate in the structural capital-flow equation will therefore be biased negatively if sterilization is incomplete. The absolute value of the bias increases when sterilization decreases and when the explanatory power of the speculative variable increases. Using the estimate $\hat{b}_1$, we will overestimate the amount of independence of monetary policy.

From (11.30) we have:

(11.32)
$$\text{cov}\left((\text{DDM})^{\psi} + \left(\frac{\text{BT}}{H_{-1}}\right)^{\psi} - (\Delta \log p)^{\psi}, (1+a) b_3 \Delta \text{SP}\right) = \frac{(1+a)^2 c}{1-ac} \text{var}\left(b_3 (\Delta \text{SP})^{\psi}\right).$$

The covariance is negative. It is 0 if $c = 0$ or $a = -1$. Its absolute value increases when sterilization increases or when the explanatory power of the speculative variable increases.[31] We will therefore overestimate the amount of offsetting capital flows and underestimate monetary control if we use the estimate from the semireduced-form capital-flow equation (11.12). Finally, under the hypothesis there will be no bias in $\hat{A}$ when we estimate the money stock reduced form (11.15)[32] because the left-out variables are not correlated with the variables on the right-hand side.

References

Argy, V., and P. J. K. Kouri. 1974. Sterilization policies and the volatility in international reserves. In R. Z. Aliber, ed., *National monetary policies and the international monetary system*. Chicago: University of Chicago Press.

Chow, G. C. 1966. On the long-run and short-run demand for money. *Journal of Political Economy* 74 (April): 111–31.

Darby, M. R. 1980. Sterilization and monetary control under pegged exchange rates: Theory and evidence. NBER Working Paper, no. 449, February. (Preliminary version of chapter 10.)

Frenkel, J. A., and H. G. Johnson. 1976. *The monetary approach to the balance of payments*. Toronto: University of Toronto Press.

Genberg, A. H. 1976. Aspects of the monetary approach to balance-of-payments theory: An empirical study of Sweden. In J. A. Frenkel and H. G. Johnson, *The monetary approach to the balance of payments*.

Herring, R. J., and R. C. Marston. 1977*a*. *National monetary policies and international financial markets*. Amsterdam: North-Holland.

———. 1977*b*. Sterilization policy: The trade off between monetary autonomy and control over foreign exchange reserves. *European Economic Review* 10: 325–43.

Hodjera, Z. 1976. Alternative approaches in the analysis of international

31. If we wanted to find the bias, we should multiply by $\text{plim}[(\hat{X}'\hat{X}/T)^{-1}]_{11}$, where X is the right-hand side variables matrix. Note that if $a = 0, c = -1$, and $V(b_3(\Delta\text{SP})^{\psi})$ is large, $V(\text{DDM}/H_{-1})$ is almost equal to $V(b_3(\Delta\text{SP})^{\psi})$. Therefore $\text{plim}[(X'X/T)^{-1}]_{11}$ is almost equal to the inverse of the variance of this variable and the bias is almost equal to -1. Then the true value of a is 0, but $\hat{a}$ is equal to -1.

32. This special case may seem plausible if most of the correlation of ΔSP with the instrument set is due to the small sample size, as noted in footnote 13 above. In that case it may seem reasonable to assume that the correlation of ΔSP with only six variables ($G_1', G_2', G_3, \Delta \log p, \Delta \log y, \text{BT}/H_{-1}$) is not far from zero.

If we consider a more general case where $\text{cov}(\text{BT}/H_{-1}, \Delta\text{SP}) > 0$, $\text{cov}(\text{BT}/H_{-1}, \Delta\text{SP}) > 0$, and $\text{cov}(G_3, \Delta\text{SP}) < 0$, then the negative bias of $\hat{b}_1$ is increased, the one of $\hat{a}$ is reduced (and may even become positive), and the reduced-form money stock estimate $\hat{A}$ is positively biased (more details may be found in Laskar 1981).

Note that when we consider the case of endogenous expectations and examine the bias due to the left-out variables BT/H_{-1} and $(\text{BP}/H_{-1})_{-1}$, we cannot suppose they are not correlated with BT/H_{-1}.

capital movements: A case study of Austria and France. *International Monetary Fund Staff Papers*, vol. 23, no. 3, November.

Kohlagen, S. W. 1977. "Rational" and "endogenous" exchange rate expectations and speculative capital flows in Germany. *Welwirtsch. Arch.* 113(4).

Kouri, P. J. K. 1975. The hypothesis of offsetting capital flows: A case study of Germany. *Journal of Monetary Economics* 1: 21–39.

Kouri, P. J. K., and M. G. Porter. 1974. International capital flows and portfolio equilibrium. *Journal of Political Economy*, May/June.

Laskar, D. M. 1981. Sterilization behavior and independence of monetary policy under a pegged exchange rates system: An econometric approach. Ph.D. dissertation, UCLA.

Magee, S. P. 1976. The empirical evidence on the monetary approach to the balance of payments and exchange rates. *American Economic Review*, May.

Michaely, M. 1971. *The responsiveness of demand policies to balance of payments: Postwar patterns.* New York and London: Columbia University Press for the National Bureau of Economic Research.

Murray, G. L. 1978. Monetary policy and capital inflow. *Economic Record*, August.

Neumann, M. J. M. 1978. Offsetting capital flows: A re-examination of the German case. *Journal of Monetary Economics* 4: 131–42.

Nurske, R. 1944. *International currency experience.* Montreal: League of Nations.

Porter, M. G. 1972. Capital flows as an offset to monetary policy: The German exprience. *IMF Staff Papers*, no. 19 (July), pp. 395–424.

Price, J. W. 1978. Time series analysis of money supply reaction functions: International evidence. Ph.D. dissertation, UCLA.

Stockman, A. C. 1979. Monetary control and sterilization under pegged exchange rates. Unpublished paper, University of Rochester, August.