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STERILIZATION AND MONETARY CONTROL UNDER PEGGED EXCHANGE RATES: THEORY AND EVIDENCE

Michael R. Darby

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Sterilization and Monetary Control Under Pegged Exchange Rates: Theory and Evidence

ABSTRACT

In veiw of recent strong evidence that substantial sterilization of the monetary effects of reserve flows occurs, a modified monetary approach model is formulated in which central banks exercise no control over their domestic money supply despite their sterilization activities. This model is compared with a more general model in which the balance of payments and domestic money supply are both influenced by the central bank's domestic policy goals. In order for the central bank to exercise monetary control, three conditions must be met: assets are not perfect substitutes, goods are not perfect substitutes, and expected depreciation is not "too responsive" to the balance of payments. The third condition may be met for small but not large reserve flows. Reduced form tests are derived which show for Canada, France, Germany, Italy, Japan, the Netherlands, and the United Kingdom that domestic policy goals strongly influenced quarterly changes in the domestic money supply; this strongly contradicts both the modified and standard monetary approach to the balance of payments. Thus there is a relevant "short-run" in which monetary authorities exercise monetary control. The paper concludes that the simpler monetary approach is no longer empirically tenable for analysis of quarterly data and that more general simultaneous models must be specified and tested.

Michael R. Darby
Department of Economics
University of California
at Los Angeles
Los Angeles, California 90024

(213) 825-3343

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STERILIZATION AND MONETARY CONTROL UNDER PEGGED EXCHANGE RATES: THEORY AND EVIDENCE

Michael R. Darby*
University of California, Los Angeles
National Bureau of Economic Research

Standard discussions of the monetary approach to the balance of payments under pegged exchange rates have proceeded on the assumption that no sterilization operations are attempted by the central banks of the nonreserve countries.[1] Recent findings of the NBER project on the International Transmission of Inflation Through the World Monetary System provide strong evidence that the direct effects on national money supplies of current balances of payments are very largely sterilized by offsetting transactions in domestic credit instruments.[2] This paper outlines in Section I a general model incorporating sterilization which encompasses as a special case a modified version of the monetary approach in which both reserve flows and domestic credit flows are endogenous variables.

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Generally, nonreserve central banks can exercise control over their domestic money supply in the short-run unless certain conditions, which imply validity of the monetary approach, are met. In this monetary-approach special case, central bank attempts to exercise monetary control are futile and instead simply induce exaggerated reserve flows.

Section II presents a simple direct test of whether determinants of monetary policy other than the current balance of payments influenced the nominal money supply given foreign variables determining money demand. For quarterly data all seven countries in our sample (Canada, France, Germany, Italy, Japan, the Netherlands, and the United Kingdom) showed clear evidence that monetary control was, in fact, exercised under the Bretton Woods system of pegged exchange rates. This evidence is strongly inconsistent with the validity of the monetary approach to the balance of payments either in its standard or modified form for analysis of quarterly data. Thus there is a relevant "short run" within which central banks can and have exercised monetary control under pegged exchange rates.

I. Analysis

The analysis proceeds in four steps: First, sterilization is formally defined in terms of the money-supply reaction function of the central bank. Next, a modified monetary approach is presented which is consistent with partial sterilization. Then a more general model is developed in which the central bank may control its domestic money supply; if this control is not present, the model reduces to the modified monetary approach. Finally, the conditions for monetary control are interpreted in terms of responsiveness of capital flows, trade flows, and the expected depreciation of the exchange rate.

A. Sterilization and the Money-Supply Reaction Function

The central bank of a nonreserve country will resist an incipient appreciation (for example) of its exchange rate by buying some foreign reserves with its domestic base money.[3] This new base money increases the domestic money supply. Standard central-bank procedure involves offsetting sales of domestic assets (for example, government bonds) for base money. These offsetting transactions are said to sterilize the effect of the balance of payments on the money supply.

In the standard monetary approach, the construct of domestic credit (base money less reserves) or its change has been assumed exogenous. This assumption is unwarranted if monetary authorities sterilize the balance of payments in whole or part so that a balance of payments surplus induces a decrease in domestic credit. But, of course, the immediate sterilization might be reversed so rapidly that for all practical purposes no sterilization occurred over a period of observation such as a quarter.

Then the exogenous-domestic-credit assumption would be acceptable for analysis of quarterly data.

A money-supply reaction function provides a formal statement of the behavior of the monetary authorities working through the banking system. The existence and extent of sterilization is measured by the coefficient of the contemporaneous scaled balance of payments in the reaction function. A general form of this reaction function is

$$\Delta \log M = \alpha \frac{B}{H} + X\beta + u \qquad (1)$$

where M is the nominal money supply, B the balance of payments surplus, H nominal base or high-powered money, and X a vector containing all other variables which systematically affect the monetary authority's behavior. Note in particular that lagged balances of payments may appear in X since the issue of ultimate concern is monetary control within the period of observation. If α is 1, then there is no sterilization since the balance of payments leads to a proportionate increase in the money supply. If α is zero, then complete sterilization is practiced. Values of α between 0 and 1 indicate partial sterilization.[4]

B. A Modified Monetary Approach

While the received monetary approach has been based on the assumption that nonreserve countries do not sterilize in whole or part, this assumption is in no sense essential to the theoretical approach.[5] The really essential idea is that the domestic money supply is demand determined given the exchange-rate-converted foreign price level and foreign interest rate. Any attempt of monetary authorities to vary the quantity of money from this demand determined growth $\overline{\Delta\log M}$ will induce massive capital flows, trade flows, or both until the money supply is equated to $\overline{\Delta\log M}$.

To illustrate, suppose that the demand-determined change in money is given by:

$$\overline{\Delta\log M} = Z\delta + \varepsilon \tag{2}$$

If the balance of payments is indeed infinitely elastic with respect to incipient deviations from $\overline{\Delta\log M}$, then

$$\frac{B}{H} = \theta\ (\Delta\log M - Z\delta - \varepsilon) \tag{3}$$

where θ is negative infinity. That is any attempt by the central bank to increase (decrease) money relative to $\overline{\Delta\log M}$ results in an unbounded balance of payments deficit (surplus). So equation (3) implies, given $\theta = -\infty$, that

$$\Delta\log M = Z\delta + \varepsilon \tag{4}$$

Equation (4) and the money-supply reaction function (1) form a recursive system in which the change in money is determined by demand and this, plus the "domestic policy" portion ($X\beta + u$) of monetary policy determine the balance of payments:

$$\frac{B}{H} = \frac{1}{\alpha}\ (Z\delta + \varepsilon - X\beta - u) \tag{5}$$

The balance of payments is the inverse of the sterilization parameter times the difference between the demand-determined money growth and the domestic-policy money growth.

The modified monetary approach is illustrated graphically in Figure 1. The vertical line indicates the infinite elasticity of the balance of payments with respect to incipient deviations of money-supply growth from its demand-determined level. The positively sloped line is the money-supply reaction function.[6] Their intersection determines the equilibrium balance of payments $\left(\frac{B}{H}\right)^{eq}$. Note that an increase in unemployment which shifted the reaction function to the right (more money growth for a given balance of payments) results in a substantial decrease in the balance of payments which just balances the desire for more money growth.

In conclusion, the existence of partial sterilization does not imply any monetary control by a nonreserve central bank under pegged exchange rates. It may just result in accentuated balance-of-payments movements.

C. A More General Model

If neither goods nor assets are perfect substitutes, it no longer follows that the balance of payments will be infinitely elastic with respect to the money supply growth rate. Other factors (such as those appearing in trade supply and demand equations) represented by the vector S will also play a role in determining the balance of payments so that equation (3) is expanded to

$$\frac{B}{H} = \theta\ (\Delta\log M - Z\delta - \varepsilon) + S\lambda \qquad (3')$$

where $0 > \theta > -\infty$. Solving for $\Delta\log M$ yields

$$\Delta\log M = \frac{1}{\theta}\frac{B}{H} - \frac{1}{\theta}S\lambda + Z\delta + \varepsilon \qquad (6)$$

When equation (6) is combined with the reaction function (1), we obtain a truly simultaneous system determining $\Delta\log M$ and $\frac{B}{H}$ together. The (reduced-form) solutions for the equilibrium values are

$$\Delta\log M = \frac{1}{1 - \alpha\theta} X\beta + \frac{\alpha}{1 - \alpha\theta} S\lambda + \frac{\alpha\theta}{\alpha\theta - 1} Z\delta + \frac{1}{1 - \alpha\theta} u + \frac{\alpha\theta}{\alpha\theta - 1} \varepsilon \quad (7)$$

$$\frac{B}{H} = \frac{\theta}{1 - \alpha\theta} X\beta + \frac{1}{1 - \alpha\theta} S\lambda + \frac{\theta}{\alpha\theta - 1} Z\delta + \frac{\theta}{1 - \alpha\theta} u + \frac{\theta}{\alpha\theta - 1} \varepsilon \quad (8)$$

It can be readily verified that as the balance of payments elasticity goes to negative infinity the solutions (7) and (8) go to the modified monetary approach solutions (4) and (5). Thus, the modified monetary approach is, indeed, a special case (for $\theta = -\infty$) of this more general model.

The more general model is illustrated by Figure 2. The vertical line of Figure 1 is replaced with a negatively slope line relating the balance of payments to money growth, the trade factors $S\lambda$, and the demand variables $Z\delta + \varepsilon$. The intersection of this line with the reaction function determines both the balance of payments and money supply growth. In this case, a desire to increase money growth (due to increased unemployment, say) in fact does increase money growth as well as decreasing the balance of payments. The relative size of the two effects of course depends on the slopes of the two equations.

Note that our model deletes the concept of domestic credit entirely. One can derive the equilibrium value of the scaled change in domestic credit from equations (7) and (8) -- or (4) and (5) in the modified-monetary-approach special case -- and the usual identity taking the growth rate of the money multiplier as given, but it is an accounting construct which as an endogenous variable adds nothing to the exposition. As will be discussed further in Section II, the negative correlation between the scaled change in domestic credit and the scaled balance of payments makes for easy confusion in empirical analysis.

D. Conditions for Monetary Control

Unless the balance of payments is infinitely elastic with respect to money growth, the central bank of a nonreserve country does exercise a degree of monetary control. This control is not absolute (if $\alpha > 0$) in the sense that the balance-of-payments effects will enter the bank's choice of money growth, but neither will these effects completely overwhelm all other influences such as domestic unemployment or inflation goals. Since lagged balances of payments may be counted among those other influences, the pegged system may be quite stable dynamically via specie-flow type adjustments, but this is a different process than envisioned by the monetary approach. This subsection examines in more detail the crucial parameter $\theta = \frac{d\ (B/H)}{d\ \Delta \log M}$.

Whether θ is negative infinity has generally been addressed in terms of either assets or goods being perfect substitutes internationally. If assets are perfect substitutes and the derivative of the interest rate R with respect to money growth is negative due to a liquidity effect, then overwhelming capital flows will force the domestic interest rate to its parity value. Similarly if goods are perfect substitutes and the derivative of the contemporaneous price level P with respect to money growth is positive, overwhelming trade flows will force the domestic price level to its parity value. Either of these cases are sufficient, but it is not necessary for either or both to hold in order to obtain $\theta = -\infty$.

To see this, write the scaled balance of payments as the difference between the scaled balance of trade and the scaled net capital outflows

$$\frac{B}{H} \equiv \frac{T}{H} - \frac{C}{H} \tag{9}$$

scaled net capital outflows will be a function of the current covered interest differential (adjusted for expected exchange rate changes) and other variables which may be taken as given for the current period:

$$\frac{C}{H} = f\ (R - \rho - R^F) \tag{10}$$

where ρ is the expected depreciation of the exchange rate ($\rho < 0$ implies an expected appreciation), R^F is the given foreign interest rate, and so f' is negative. We can find θ by differentiating equation (9)

$$\theta \equiv \frac{d\ (B/H)}{d\ \Delta\log\ M} = \frac{d\ (T/H)}{d\ \Delta\log\ M} - f'\ \frac{dR}{d\ \Delta\log\ M} \quad f'\ \frac{d\rho}{d\ (B/H)}\ \frac{d\ (B/H)}{d\ \Delta\log\ M}$$

$$\theta = \frac{1}{1 - f'\ \dfrac{d\rho}{d\ (B/H)}} \left(\frac{d\ (T/H)}{d\ \Delta\log\ M} - f'\ \frac{dR}{d\ \Delta\log\ M}\right) \tag{11}$$

The multiplier $1/\left(1 - f'\ \frac{d\rho}{d\ (B/H)}\right)$ states that if the expected depreciation ρ responds to the size of the balance of payments (as an indicator of the probability and size of a revaluation), then the direct trade and capital flow effects will be reinforced by induced "speculative" capital flows. These induced speculative capital flows will be overwhelming unless

$$f'\ \frac{d\rho}{d\ (B/H)} < 1 \tag{12}$$

Therefore, there are three conditions required for a $\theta > -\infty$: (1) Trade flows must not be overwhelming.[7] (2) The direct effect on capital flows must not be overwhelming.[8] (3) Speculative capital flows must not be overwhelming (condition (12) must be met). Note that with costs of adjustment and lags in information these three conditions may be met for certain periods of observation but not for longer periods. With longer periods lagged values of $\frac{B}{H}$ which are included in $X\beta$ in the short-period analysis would instead be included in the contemporaneous value of $\frac{B}{H}$.

Obviously it is an empirical question whether these three conditions for monetary control are met for any relevant observation length, and we shall turn to some empirical evidence shortly in Section II. But first, the third condition (12) raises an interesting possibility. Suppose that the probability of a revaluation increases with the absolute value of the scaled balance of payments and the expected (signed) magnitude of the revaluation varies with the value of the scaled balance of payments. Then the expected depreciation might be determined by a function like

$$\rho = g\left(\left|\frac{B}{H}\right| \cdot \frac{B}{H}\right) \tag{13}$$

where g' is, of course, negative. The derivative of interest is

$$\frac{d\rho}{d\ (B/H)} = 2g'\left|\frac{B}{H}\right| \tag{14}$$

which increases in absolute value with the absolute value of B/H. Thus, there is some reason to suppose that condition (12) might hold for "small" absolute values of the scaled balance of payments but fail if the central bank attempted a policy which is "too" inconsistent with international conditions. This is illustrated in Figure 3. The central bank exercises a degree of monetary control so long as it stays in the negatively sloped portion of the international balance curve. If it shifts into the vertical range, however, overwhelming speculative capital flows result.[9]

II. Empirical Results

Blejer (1979) applied the Granger-Sims causality test to quarterly data for France, Germany, Italy, Sweden, and the United Kingdom and found that scaled changes in domestic credit "cause" scaled reserve flows in all five (albeit as part of a two-way feedback structure for Sweden and the United Kingdom). Blejer erroneously claimed that this supports the monetary approach, but it in fact suggests short-run monetary control since the test shows that past changes in domestic credit affect current reserve flows. This evidence for short-run monetary control is not conclusive, however, since past changes in domestic credit might have been induced by reserve country actions which have current effects on foreign prices and hence reserve flows.[10] It is simply not appropriate to apply an exogeneity test to two endogenous variables.

The analysis of Section I suggests two research strategies which focus directly on the issue of monetary control: The first is to fully specify the more general model and estimate equations (1) and (6) by a simultaneous system method to test whether $\frac{1}{\theta}$ is, indeed, zero. This method is being pursued in the Mark III International Transmission Model and is beyond the scope of the present paper.[11] The second approach is to proceed on the assumption that the null hypothesis of no monetary control is true and perform some classical hypothesis tests. Following this second path allows us to avoid the difficulty of fully specifying the variables which belong in S.

These hypothesis tests rely on the difference between the reduced forms for $\Delta\log M$ under the null hypothesis and the alternative hypothesis. Rewriting the reduced forms here for comparison

$$\Delta\log M = Z\delta + \varepsilon \tag{4}$$

$$\Delta\log M = \frac{1}{1-\alpha\theta} X\beta + \frac{\alpha}{1-\alpha\theta} S\lambda + \frac{\alpha\theta}{\alpha\theta-1} Z\delta + \frac{1}{1-\alpha\theta} u + \frac{\alpha\theta}{\alpha\theta-1} \varepsilon \tag{7}$$

Note that neither $X\beta$ nor $S\lambda$ enter in the reduced form if the null hypothesis is true. One test of the null hypothesis is to add the domestic variables $X\beta$ to the reduced form (4) and test whether they fail to enter as required by the null hypothesis. That is, the null hypothesis implies $\phi = 0$ in

$$\Delta\log M = \phi X\beta + Z\delta + \varepsilon \tag{15}$$

A more powerful test would also include $S\lambda$, but this requires a full specification of the alternative hypothesis as noted above.

The empirical tests are based on the quarterly data bank developed for the NBER Project on the International Transmission of Inflation and the money-supply reaction functions in the Mark III model, both of which are described in Darby and Stockman (1979). We must first specify which variables appear in the vector Z. Following Stockman's standard form, we include in Z the change in the U.S. interest rate ΔR_U, the change in domestic real income $\Delta\log y$,[12] and the change in an exchange-rate-converted income-weighted index of foreign prices $\Delta\log(EP_F)$.[13] Table 1 reports estimates of the reduced-form (and structural) equation (4) for $\Delta\log M$ on this specification of Z for all seven nonreserve countries in the data bank. The pegged periods used in the estimates are indicated in the table. These regressions seem very poor compared to standard monetary approach results. The reason is that standard estimates move domestic credit to the righthand side on the erroneous assumption that it is exogenous. This provides a spuriously high R^2.

Following Genberg (1976), we can improve the fit of the regressions by using the short-run money-demand function introduced by Chow (1966). This amounts to adding the change in the logarithm of lagged real money or $\Delta \log (M/P)_{-1}$ to the vector Z. Table 2 reports the results obtained using the Chow specification. These results are rather more favorable to the monetary approach although the $\bar{R}^2$s are not very impressive in an absolute sense. Let us now proceed to the reduced-form tests.

The reaction functions in the Mark III model are very general in form to allow for cross-country differences in timing of response. For the pegged period included variables, other than a scaled balance of payments term, are a time trend, current and lagged unexpected real government spending, lagged semiannual inflation rates, lagged unemployment rates or logarithmic transitory incomes, and lagged scaled balance of payments. When all these variables (except the current B/H) are added to the regressions reported in Tables 1 and 2, we can do the joint test whether the coefficients of the additional variables are all zero as implied by the null hypothesis. The results of these F tests are reported in Table 3. For the Chow-money-demand-function the modified monetary approach (no monetary control) is rejected strongly for the United Kingdom, France, and Japan and at the 10 percent significance level for Canada and Germany. Similar, though more erratic, results are obtained for the long-run-money-demand function. Consider the tests, however: They ask whether all the additional variables reduce the sum of squared residuals by significantly more than would be expected for such a number of unrelated random variables. Since not all of these variables enter any given reaction function this is a low-power test (it is hard to reject the null hypothesis).

A sharper test first estimates equation (1) using fitted values of B/H based on all the variables in X and Z. Since X and Z are independent of ϵ, the resulting estimated $X\hat{\beta}$ should not enter in equation (15) if the null hypothesis is true. This saves degrees of freedom by imposing the constraint implied by the alternative hypothesis: that the domestic policy variables enter proportionally to how they enter in the reaction function.

Tables 4 and 5 report regressions corresponding to those in Tables 1 and 2 with the addition of a term in $X\hat{\beta}$. We now see that in every case but one (Canada in Table 4) ϕ differs significantly from zero and so we can reject the null hypothesis of no monetary control.[14] The difficulty with Canada in Table 4 appears to be in estimating a reaction function using only data for the brief period that Canada was on a pegged exchange rate and only the long-run money demand variables in the instrument list; $X\hat{\beta}$ also enters significantly (t-statistic of 2.59) for Canada if the $\hat{\beta}$ estimated in the Mark III model using data for 1957I-1976IV is substituted.

III. Summary and Conclusions

Recent empirical research on sterilization had demonstrated that standard monetary approach models which assume domestic credit exogenous are invalid. This paper presents a modified monetary approach model which retains the message of central-bank impotence despite extensive sterilization activities. A more general model was also sketched under which the central bank's policy objectives do influence the change in the money supply. There was very strong evidence of at least short-run monetary control in the quarterly data examined. This need not indicate any long-run monetary control, but I conclude that the simplicity of the monetary approach (in standard or modified form) is no longer empirically tenable for use with quarterly data. More general models must be specified and tested to explain the simultaneous determination of nominal money and the balance of payments under pegged exchange rates.

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FOOTNOTES

[1]To cite the locus classicus, see for example, Frenkel and Johnson (1976, passim esp. pp. 152-153). An important recent exception is a theoretical analysis by Boyer (1979) which uses a portfolio balance approach.

[2]See Darby and Stockman (1979), Stockman (1979), and Laskar (1979). Previously Argy and Kouri (1974) had also found evidence of sterilization, but Genberg (1976) using a very rudimentary reaction function (the only variables were the scaled balance of payments and government deficit) did not. From their review of the earlier literature on sterilization and monetary control, Sweeney and Willett (1976, p. 444) conclude that "there is little evidence that such automony is impossible in the short-run, and considerable evidence it is possible."

[3]The analysis is properly applied only to nonreserve countries if the reserve country (such as the United States) is on a fiat standard as discussed in Darby (1980).

[4]By way of information, the evidence cited in footnote 2 above generally finds α to lie between 0 and 0.2 or at most 0.3. This implies that substantial but not necessarily complete sterilization was the standard practice for those nonreserve industrial countries which were examined.

[5]Harry Johnson (1976, pp. 152-153) noted that the monetary "approach assumes -- in some cases, asserts -- that these monetary inflows or outflows associated with surpluses or deficits are not sterilized -- or cannot be, within a period relevant to policy analysis -- but instead influence the domestic money supply." But Mussa (1976, p. 192) rightly

observes that this assumption is unnecessary: "If the monetary authorities sterilize the balance-of-payments surplus created by, say, the imposition of a tariff, then the monetary approach predicts that there will be a further surplus, equal to the reduction in the domestic source component of the base which is implied by sterilization, and so on, until the sterilization operations cease." This subsection merely works out the analytical framework sketched by Mussa. The author (1980) has commented elsewhere on the inappropriateness of the empirical tests of the monetary approach that have proceeded on the maintained assumption of exogenous domestic credit.

[6]If this line were vertical ($\alpha = 0$) there would generally be no equilibrium in the modified monetary approach case. A negative slope ($\alpha < 0$) implies an unstable equilibrium.

[7]Formally,

$$\frac{\partial\ (T/H)}{\partial \log P}\ \frac{d \log P}{d\ \Delta\log M} > -\infty$$

[8]Formally,

$$f'\ \frac{dR}{d\ \Delta\log M} < \infty$$

[9]This provides another basis for Niehan's idea (1974) that non-reserve countries can exercise monetary control within a limited range.

[10]I am indebted to Anthony Cassese and James Lothian for this point.

[11]See Darby and Stockman (1979). Equation (6) can be thought of as a semi-reduced form of all the non-reaction-function equations in the

model. Stockman (1979) dealt with this problem by implicitly assuming $S\lambda = 0$ in equation (6) and estimating transformations of equations (1) and (6) by two-stage least squares. Since $S\lambda \neq 0$ if the alternative hypothesis is true, his estimates of $\frac{1}{\theta}$ are inconsistent and likely biased toward zero. In view of this specification error, his failure to find evidence of monetary control does not seem very informative. This and other criticisms apply to Argy and Kouri (1974). If one is to use a simultaneous-equation approach, the general model must be fully specified.

[12]The change in domestic real income might well be endogenous, but following Stockman we take the monetary approach strictly here.

[13]All tables in this paper were also computed using the exchange-rate-converted U.S. price index EP_U instead of EP_F. The standard errors were generally a bit lower for the form reported here, but the basic results were qualitatively the same. The alternate tables are available upon request from the author.

[14]Note that the estimated value of ϕ cannot be interpreted in terms of structural parameters since S is not fully specified here. The approach here is testing, not estimation.

TABLE 1

ESTIMATES OF MODIFIED MONETARY APPROACH EQUATION: LONG-RUN-MONEY-DEMAND VERSION

$$\Delta \log M = \delta_1 + \delta_2 \Delta \log y + \delta_3 \Delta R_U + \delta_4 \Delta \log (EP_F) + \varepsilon$$

		Coefficient of						
Country	Period	Const.	Δlog y	ΔR_U	Δlog (EP_F)	S.E.E.	$\bar{R}^2$	D-W
United Kingdom	1957 I- 1971 II	0.008 (0.003) 2.520	0.108 (0.202) 0.535	0.084 (0.481) 0.174	0.065 (0.160) 0.406	0.018	-0.045	1.46
Canada	1962 III- 1970 I	0.025 (0.007) 3.794	-0.207 (0.257) -0.806	-1.640 (0.606) -2.707	-0.608 (0.520) -1.170	0.011	0.188**	1.93
France	1958 I- 1971 II	0.028 (0.003) 10.664	0.067 (0.092) 0.720	-0.271 (0.351) -0.772	-0.218 (0.092) -2.355	0.013	0.094**	0.68
Germany	1957 I- 1971 I	0.018 (0.002) 8.860	0.323 (0.102) 3.169	-0.188 (0.283) -0.664	0.269 (0.118) 2.278	0.011	0.169**	1.44
Italy	1957 I- 1971 II	0.028 (0.004) 7.111	0.097 (0.147) 0.657	-0.450 (0.371) -1.213	0.497 (0.369) 1.348	0.014	0.014	1.37
Japan	1957 I- 1971 II	0.030 (0.006) 5.117	0.153 (0.177) 0.867	0.466 (0.527) 0.884	0.753 (0.515) 1.462	0.020	0.013	0.99
Netherlands	1957 I- 1971 I	0.017 (0.003) 6.069	0.369 (0.146) 2.522	-0.118 (0.358) -0.329	-0.043 (0.235) -0.183	0.014	0.060*	1.92

Notes: 1. Standard errors appear in parentheses below the coefficient estimates; t-statistics are below the standard errors.

2. One asterisk after the $\bar{R}^2$ indicates rejection of the hypothesis $Z_2 = Z_3 = Z_4 = 0$ at better than 0.10 level; two asterisks at better than 0.05 level.

TABLE 2

ESTIMATES OF MODIFIED MONETARY APPROACH EQUATION: CHOW-MONEY-DEMAND VERSION

$$\Delta \log M = \delta_1 + \delta_2 \Delta \log y + \delta_3 \Delta R_U + \delta_4 \Delta \log (EP_F) + \delta_5 \Delta \log (M/P)_{-1} + \varepsilon$$

	Coefficient of							
Country	Const.	Δlog y	ΔR_U	Δlog (EP_F)	Δlog $(M/P)_{-1}$	S.E.E.	$\bar{R}^2$	D-W
United Kingdom	0.008 (0.003) 2.691	0.047 (0.198) 0.240	0.123 (0.469) 0.263	0.023 (0.157) 0.150	0.279 (0.137) 2.032	0.018	0.012	1.95
Canada	0.025 (0.007) 3.731	-0.211 (0.262) -0.805	-1.667 (0.622) -2.680	-0.598 (0.529) -1.130	-0.052 (0.163) -0.316	0.012	0.160*	1.82
France	0.015 (0.003) 6.137	0.050 (0.064) 0.776	-0.415 (0.243) -1.705	-0.078 (0.067) -1.166	0.617 (0.083) 7.465	0.009	0.568**	1.67
Germany	0.015 (0.003) 5.036	0.326 (0.100) 3.254	-0.201 (0.278) -0.721	0.311 (0.119) 2.613	0.197 (0.118) 1.663	0.011	0.196**	1.87
Italy	0.022 (0.005) 4.692	0.073 (0.143) 0.514	-0.323 (0.364) -0.887	0.346 (0.365) 0.950	0.292 (0.138) 2.116	0.014	0.074*	1.98
Japan	0.021 (0.006) 3.638	0.032 (0.160) 0.198	0.128 (0.477) 0.269	0.320 (0.472) 0.680	0.486 (0.125) 3.896	0.018	0.219**	1.80
Netherlands	0.015 (0.003) 4.808	0.336 (0.148) 2.278	-0.136 (0.355) -0.384	0.009 (0.236) 0.037	0.157 (0.117) 1.341	0.014	0.074*	2.27

Notes: 1. Standard errors appear in parentheses below the coefficient estimates; t-statistics are below the standard errors.

2. One asterisk after the $\bar{R}^2$ indicates rejection of the hypothesis $Z_2 = Z_3 = Z_4 = 0$ at better than 0.10 level; two asterisks at better than 0.05 level.

TABLE 3

F TESTS FOR UNCONSTRAINED ADDITION OF DOMESTIC-POLICY REACTION-FUNCTION VARIABLES

Country	F-Statistics: Chow-Money-Demand Function	F-Statistics: Long-Run-Money-Demand Function
United Kingdom	2.241 [0.025>p>0.01]	2.731 [0.01>p>0.005]
Canada	2.085 [0.10>p>0.05]	1.495 [p>0.10]
France	2.658 [0.025>p>0.01]	4.040 [0.001>p]
Germany	1.929 [0.10>p>0.05]	2.239 [0.05>p>0.025]
Italy	1.250 [p>0.10]	1.651 [p>0.10]
Japan	2.643 [0.025>p>0.01]	4.287 [0.001>p]
Netherlands	1.372 [p>0.10]	1.571 [p>0.10]

Notes: 1. Significance levels are indicated in bracket below the F-Statistics.

2. The significance levels refer to the level at which we would just reject the null hypothesis that the coefficients on all reaction function variables equal zero. The twelve reaction function variables are:

t, $\hat{g}$, $(\hat{g}_{t-1} + \hat{g}_{t-2})$, $(\hat{g}_{t-3} + \hat{g}_{t-4})$, $(\log P_{t-1} - \log P_{t-3})$, $(\log P_{t-3} - \log P_{t-5})$, u_{t-1}, u_{t-2}, u_{t-3}, u_{t-4}, $[(B/H)_{t-1} + (B/H)_{t-2}]$, and $[(B/H)_{t-3} + (B/H)_{t-4}]$ where t is time, $\hat{g}$ the innovation in real government spending, P the GNP deflator, and u either the unemployment rate (for the U.K. and France) or logarithmic transitory income.

TABLE 4

CONSTRAINED TESTS OF MODIFIED-MONETARY-APPROACH EQUATION: LONG-RUN-MONEY-DEMAND VERSION

$$\Delta \log M = \phi \cdot X\hat{\beta} + \delta_1 + \delta_2 \Delta \log y + \delta_3 \Delta R_U + \delta_4 \Delta \log (EP_F) + \epsilon$$

Country	Coefficient of $X\hat{\beta}$	Const.	$\Delta \log y$	ΔR_U	$\Delta \log (EP_F)$	S.E.E.	$\bar{R}^2$	D-W
United Kingdom	1.087 (0.187) 5.823***	0.002 (0.003) 0.744	0.037 (0.159) 0.239	-0.006 (0.380) -0.016	-0.306 (0.141) -2.170	0.014	0.350	2.17
Canada	-0.034 (0.029) -1.171	0.027 (0.007) 3.995	-0.217 (0.255) -0.851	-1.719 (0.606) -2.838	-0.704 (0.523) -1.347	0.011	0.199	1.91
France	0.988 (0.137) 7.189***	0.002 (0.004) 0.424	0.008 (0.066) 0.122	-0.188 (0.248) -0.759	-0.050 (0.069) -0.721	0.009	0.550	1.21
Germany	0.795 (0.164) 4.848***	0.005 (0.003) 1.768	0.225 (0.088) 2.562	-0.177 (0.237) -0.748	0.273 (0.099) 2.755	0.009	0.417	1.95
Italy	0.829 (0.196) 4.225***	0.001 (0.007) 0.134	0.140 (0.129) 1.089	-0.504 (0.324) -1.557	0.172 (0.331) 0.518	0.013	0.249	1.69
Japan	1.091 (0.162) 6.731***	-0.005 (0.007) -0.745	0.082 (0.132) 0.624	-0.293 (0.406) -0.722	0.151 (0.392) 0.385	0.015	0.458	1.45
Netherlands	1.006 (0.224) 4.489***	0.002 (0.004) 0.608	0.097 (0.139) 0.694	-0.207 (0.307) -0.675	-0.238 (0.206) -1.157	0.012	0.309	2.09

Notes: 1. Standard errors appear in parentheses below the coefficient estimates; t-statistics are below the standard errors.

2. The vector X contains a constant plus the twelve variables in Note 2 to Table 3. The estimated $\hat{\beta}$ is from the OLS regression $\Delta \log M = \alpha \frac{\hat{B}}{H} + X\beta + u$ where $\frac{\hat{B}}{H}$ are the fitted values of B/H on X and the variables multiplying δ_1, δ_2, δ_3, and δ_4 above.

3. One asterisk following the t-statistic for $X\hat{\beta}$ indicates rejection of the null hypothesis at the 0.10 level or better; two asterisks indicates rejection at the 0.01 level or better; and three asterisks indicate rejection at the 0.001 level or better.

TABLE 5

CONSTRAINED TESTS OF MODIFIED-MONETARY-APPROACH EQUATION: CHOW-MONEY-DEMAND VERSION

$$\Delta \log M = \phi \cdot X\hat{\beta} + \delta_1 + \delta_2 \Delta \log y + \delta_3 \Delta R_U + \delta_4 \Delta \log (EP_F) + \delta_5 \Delta \log (M/P)_{-1} + \epsilon$$

Country	Coefficient of $X\hat{\beta}$	Const.	$\Delta \log y$	ΔR_U	$\Delta \log (EP_F)$	$\Delta \log (M/P)_{-1}$	S.E.E.	$\bar{R}^2$	D-W
United Kingdom	1.141	0.002	0.047	-0.019	-0.315	-0.063	0.015	0.341	2.09
	(0.218)	(0.003)	(0.162)	(0.384)	(0.143)	(0.130)			
	5.242***	0.582	0.293	-0.050	-2.199	0.488			
Canada	0.639	0.017	-0.045	-1.366	-0.744	-0.224	0.009	0.492	1.88
	(0.151)	(0.006)	(0.207)	(0.489)	(0.413)	(0.133)			
	4.239***	2.976	-0.218	-2.793	-1.800	-1.680			
France	0.437	0.007	0.040	-0.322	-0.062	0.400	0.008	0.666	1.72
	(0.111)	(0.003)	(0.056)	(0.215)	(0.059)	(0.091)			
	3.922***	2.219	0.717	-1.495	-1.050	4.388			
Germany	0.784	0.005	0.226	-0.178	0.277	0.024	0.009	0.407	1.99
	(0.177)	(0.003)	(0.089)	(0.239)	(0.102)	(0.109)			
	4.416***	1.585	2.546	-0.744	2.708	0.219			
Italy	0.724	0.001	0.125	-0.437	0.163	0.131	0.013	0.239	1.94
	(0.205)	(0.007)	(0.130)	(0.332)	(0.335)	(0.133)			
	3.532***	0.198	0.957	-1.317	0.487	0.987			
Japan	0.910	0.187	0.057	-0.239	-0.146	0.129	0.013	0.607	1.98
	(0.125)	(0.023)	(0.114)	(0.342)	(0.341)	(0.101)			
	7.298***	8.091	0.503	-0.700	-0.430	1.272			
Netherlands	1.014	0.002	0.098	-0.165	-0.232	-0.001	0.012	0.307	2.11
	(0.235)	(0.004)	(0.139)	(0.307)	(0.212)	(0.108)			
	4.306***	0.422	0.708	-0.538	-1.097	-0.006			

Notes:

1. Standard errors appear in parentheses below the coefficient estimates; t-statistics are below the standard errors.
2. The vector X contains a constant plus the twelve variables in Note 2 to Table 3. The estimated $\hat{\beta}$ is from the OLS regression $\Delta \log M = \alpha \frac{\hat{B}}{H} + X\beta + u$ where $\frac{\hat{B}}{H}$ are the fitted values of B/H on X and the variables multiplying δ_1, δ_2, δ_3, δ_4, and δ_5 above.
3. One asterisk following the t-statistic for $X\hat{\beta}$ indicates rejection of the null hypothesis at the 0.10 level or better; two asterisks indicates rejection at the 0.01 level or better; and three asterisks indicate rejection at the 0.001 level or better.

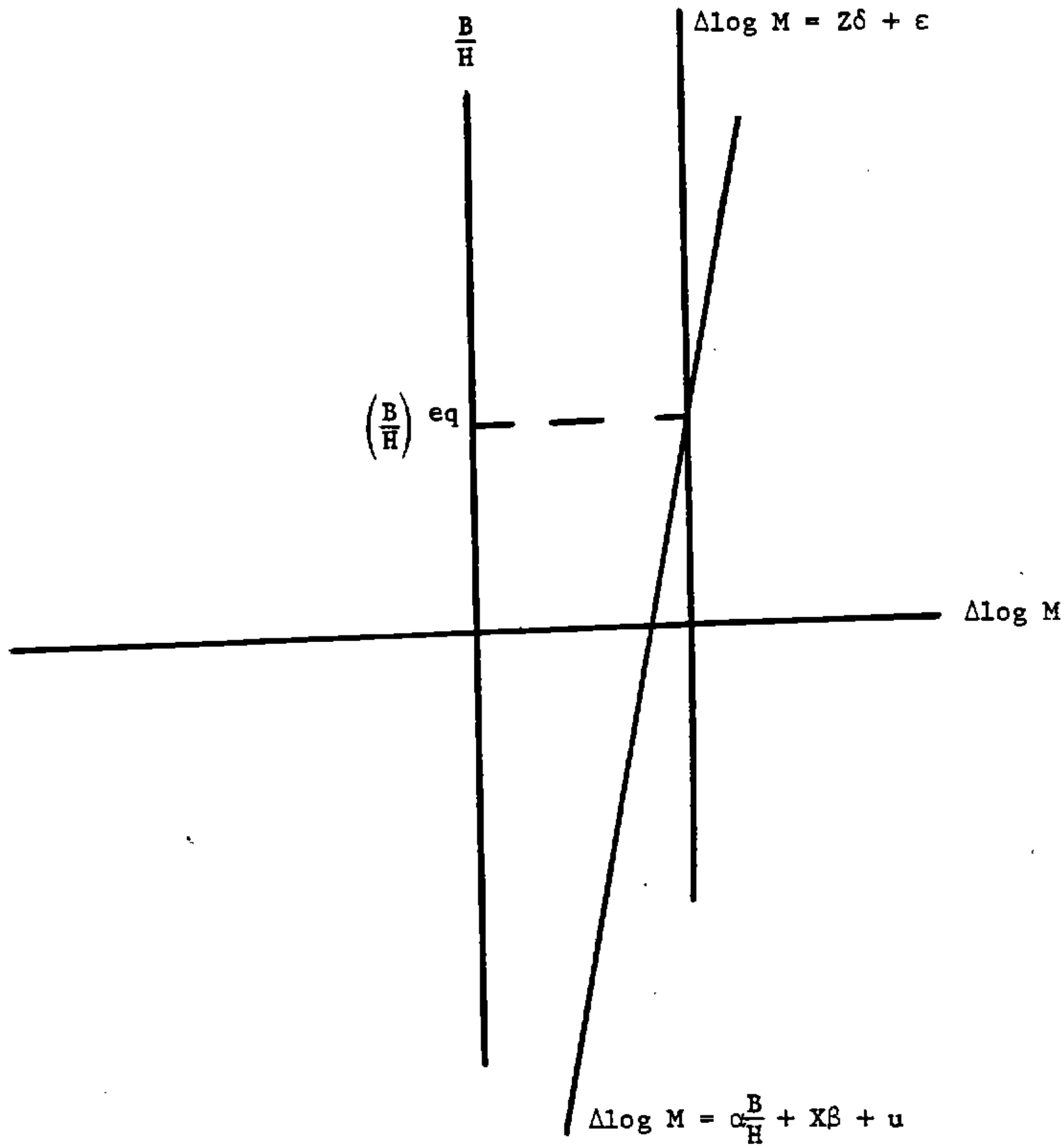

Figure 1

Determination of Balance of Payments in the Modified Monetary Approach

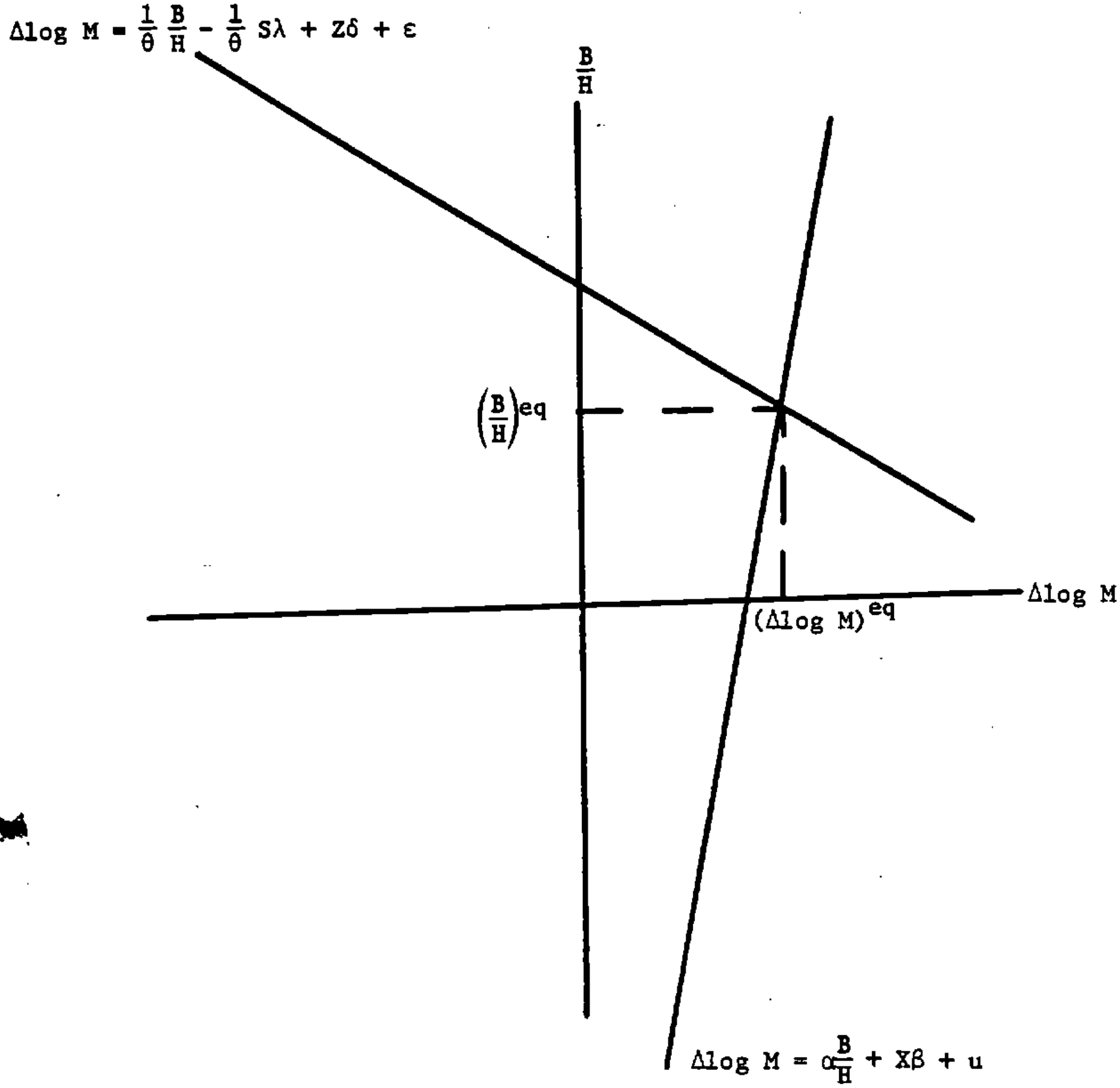

Figure 2

Simultaneous Determination of Balance of Payments and Nominal Money in the More General Model

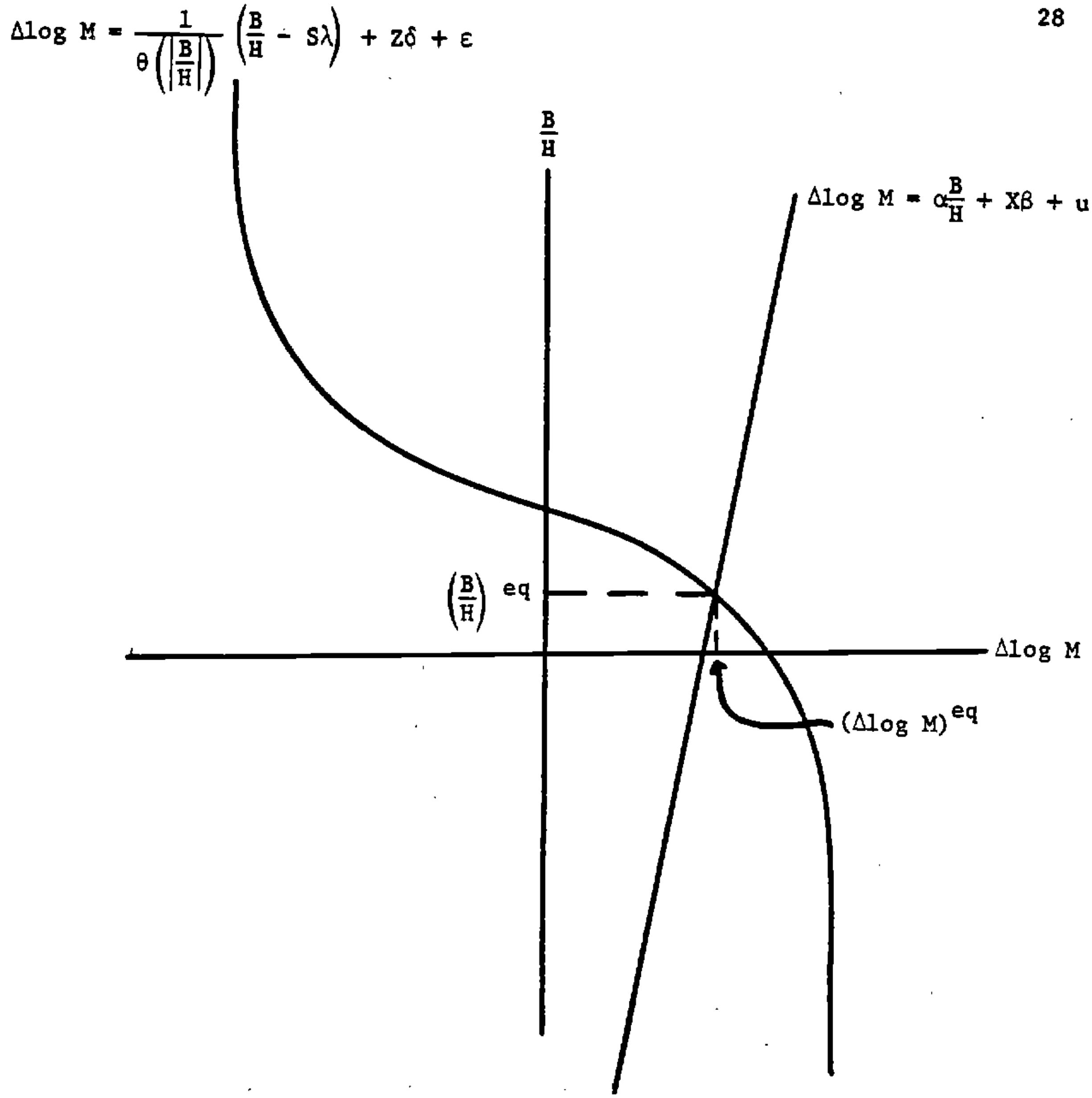

Figure 3

Simultaneous Determination of Balance of Payments and Money Where Potential Unstable Speculation Limits Monetary Control