CAN WE STERILIZE? THEORY AND EVIDENCE

Maurice Obstfeld

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Abstract

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for sterilized intervention in foreign exchange markets under alternative

exchange-rate regimes. Section I demonstrates the potential importance of

simultaneous-equations bias in single-equation econometric studies of the

capital-account offset to monetary policy under fixed exchange rates. The

empirical record suggests that, in the case of West Germany, sterilization

was a feasible short-run monetary strategy in the 1960s. Section II notes

that there is considerable recent evidence of imperfect asset substitutability

under the managed float. While limited substitution between bonds of dif-

ferent currency denomination is a precondition for the efficacy of sterilized

foreign-exchange intervention, it is no guarantee of efficacy. Whether

limited substitutability can in fact be exploited in a predictable manner

by central banks is a distinct, and unanswered, question.

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Under managed floating, as under the Bretton Woods system, central banks have intervened heavily in the foreign exchange market. As before, they have often attempted to divorce their intervention activities from their money supplies through offsetting operations in domestic financial markets. An official purchase of foreign exchange can be sterilized through a corresponding open-market sale of domestic securities. The transaction, which is equivalent to an official forward sale of domestic currency, leaves relative money supplies unchanged but alters the relative supplies of foreign- and domestic-currency bonds available to the public.

Regardless of the exchange-rate regime, sterilized intervention may be viewed as an attempt to attain independent exchange-rate and money-stock targets in the short run. For this to be possible, bonds denominated in different currencies must be imperfect substitutes in private portfolios. If feasible, sterilization may or may not be useful in attaining the long-run objectives of the Central Bank.

This paper is a highly selective review of our knowledge about the scope for sterilization. Section I demonstrates the potential importance of simultaneous-equations bias in single-equation econometric studies of the capital-account offset to monetary policy under fixed exchange rates. The empirical record suggests that, at least in the case of West Germany, sterilization was a feasible short-run strategy in the 1960s. Section II notes that there is considerable recent evidence of imperfect asset substitutability under the managed float. Whether this limited substitutability can be exploited in a predictable manner by central banks is a distinct, and unanswered, question.

I. The Scope for Sterilization under Fixed Exchange Rates

When the exchange rate is fixed and capital is internationally mobile,
the central problem of monetary management is the endogeneity of the home money
supply. Domestic credit expansion aimed at affecting internal markets causes
an incipient weakening of the exchange rate. To maintain the official parity,
the Central Bank must intervene in the foreign exchange market by buying high-
powered money with foreign reserves. In this manner, attempts to alter the
domestic source component of the monetary base are impeded, even in the short
run, by offsetting movements in its domestic source component. If the offset
to domestic credit expansion is complete, the monetary base is determined
independently of the Central Bank's policies by the saving and portfolio deci-
sions of the public. In particular, attempts to sterilize reserve flows through
offsetting domestic credit measures cannot succeed, even temporarily.

The Central Bank can affect the monetary base through open-market operations
only when domestic- and foreign-currency bonds are imperfect substitutes in in-
vestors' portfolios; under perfect substitutability, the capital-account offset
to domestic credit measures is immediate and complete, provided there are no lags
in portfolio adjustment (see Robert Mundell). However, limited substitutability
is in itself no guarantee of monetary autonomy. If a rational public anticipates
the future tax liabilities implied by the government's debt and the Central Bank's for-
eign reserve holdings, and so "internalizes" the public-sector budget constraint,
official operations in interest-bearing assets will not alter outside asset sup-
plies. Accordingly, such operations will have no influence on the domestic inter-
est rate or money supply even when various risks drive a wedge between home and
foreign interest rates (see the author (1982) and Alan Stockman).

The offset coefficient--the fraction of any domestic credit expansion
reversed by Central Bank foreign reserve losses in the same quarter--provides

a useful summary measure of the scope for a domestically-oriented monetary policy. In reality, this offset depends on the current-account as well as the capital-account response to domestic credit creation. Empirical studies of the offset coefficient have typically assumed that the capital-account response is dominant in the short run, and so regard the current account and income as pre-determined. The offset coefficient is therefore interpreted as a measure of capital-account sensitivity to domestic credit expansion, with a coefficient of unity indicating a complete offset.

Within the foregoing framework, there are essentially two approaches to empirical estimation of the offset coefficient. The first, a reduced-form approach, derives from the bond- and money-market equilibrium conditions and the Central Bank's balance sheet an approximate linear equation relating the quarterly capital-account surplus (CAP_t) to the change in domestic credit over the quarter (ΔDC_t), the change in the foreign bond rate (ΔR_t^*), the change in nominal income (ΔY_t), the current account balance $(CURR_t)$, a vector X_t of additional, exogenous determinants of the capital account, and a mean-zero stochastic disturbance (u_t):

$$(1) \quad CAP_t = \alpha_0 + \alpha_1 \Delta DC_t + \alpha_2 \Delta R_t^* + \alpha_3 \Delta Y_t + \alpha_4 CURR_t + X_t^{'}\beta + u_t$$

As observed by Victor Argy and Pentti Kouri and by Kouri and Michael Porter, (1) can be used to estimate the offset coefficient $-\alpha_1$. Because the domestic interest rate has been eliminated from the reduced form (1), the estimation problem caused by the potential endogeneity of that variable is avoided.

The second, structural approach to estimation looks directly at the asset-demand equations underlying (1), using structural parameter estimates to compute the implied offset to credit policy. Examples of this second approach are the

studies of West Germany by Richard Herring and Richard Marston and by the author (1980a),and the study of Mexico in the 1970s by Robert Cumby and the author (1981a). The structural approach suffers from several disadvantages relative to the reduced-form approach. For example, it may be less robust with respect to certain specification errors in structural equations. Also, unlike the reduced-form approach, it cannot be implemented when there is unlimited substitutability between domestic and foreign bonds. However, the structural approach avoids an important econometric problem which may bias reduced-form estimates.

That problem is the endogeneity of the domestic credit variable ΔDC_t in (1) when the Central Bank follows a sterilization policy. If domestic credit is systematically varied in response to the balance of payments, the regressor ΔDC_t will be correlated with the disturbance u_t to the capital-flow equation (1). Accordingly, ordinary least squares (OLSQ) estimates of the parameters in (1) will be inconsistent. In recognition of this problem, Argy and Kouri used instrumental variables to estimate (1) by two-stage least squares (2SLS). However, most single-equation studies, including Kouri and Porter, report OLSQ estimates of the offset coefficient, and convey the impression that the simultaneous-equations bias imparted to those estimates by Central Bank sterilization activities is likely to be unimportant in practice.

A detailed examination of the West German case illustrates the potential importance of the sterilization bias. The Kouri-Porter reduced-form estimate of the offset coefficient for West Germany (1960:I - 1970:IV) is .77, a figure that indicates a substantial capital-account response to domestic credit movements. Table I reports estimates of the Kouri-Porter equation based on the revised Bundesbank data series used in Manfred Neumann's study of offsetting capital flows. The estimated offset coefficients do not differ significantly from unity. [1]/

TABLE I -- REDUCED-FORM CAPITAL-FLOW EQUATION FOR WEST GERMANY

(Dependent Variable: Capital-Account Surplus)

Sample	Procedure	ΔDC	ΔR^*	ΔY	CURR	$\Delta S4$	SPEC1	SPEC2	SPEC3	R^2	D-W	$\hat{\rho}$
60:I-70:IV	OLSQ	-.934 (.051)	.371 (.190)	.037 (.017)	-1.047 (.099)	2.561 (.238)	.610 (.681)	2.326 (.713)	.968 (.921)	.962	2.37	----
60:I-70:IV	CORC	-.971 (.033)	-.099 (.138)	.021 (.010)	-.990 (.049)	2.251 (.187)	-.989 (.591)	1.107 (.663)	1.619 (.857)	.984	2.00	-.803
61:III-67:IV	OLSQ	-.555 (.082)	-.172 (.303)	.026 (.017)	-.869 (.085)	2.125 (.256)	----	----	----	.896	2.18	----
61:III-67:IV	2SLS	.003 (.472)	-.433 (.590)	-.006 (.041)	-.840 (.157)	1.049 (.982)	----	----	----	.656	2.12	----

Note: Standard errors appear in parentheses. All equations were estimated with a constant term, but estimates of the constant are not reported. S4 is a seasonal dummy variable equal to 1 in the fourth quarter and 0 in all other quarters. SPEC1, SPEC2, and SPEC3 are dummy variables associated with periods of speculative capital movements. SPEC1 = +1 in 1961:I, -1 in 1961:II, and 0 in all other quarters; SPEC2 = +1 in 1968:IV, -1 in 1969:1, and 0 in all other quarters; and SPEC3 = +1 in 1969:III, -1 in 1969:IV, and 0 in all other quarters. The three estimation procedures used were ordinary least squares (OLSQ), the Cochrane-Orcutt iterative procedure (CORC), and two-stage least squares (2SLS). The instrumental variables used in forming the 2SLS estimates are described in the text.

Structural estimates of the offset are considerably lower. Simulation of Herring and Marston's dynamic multi-equation model yields an offset similar to that estimated by Kouri and Porter only after asset markets have been allowed to adjust over a period of sixteen quarters. The one-quarter offset is much smaller. Similarly, the structural model of Obstfeld (1980a) yields a short-run offset between .10 and .15.

A substantial portion of the discrepancy between the structural and reduced-form estimates is explained by the inclusion of periods of speculative turbulence in the reduced-form data sample.[2/] When the Kouri-Porter equation is estimated instead over the tranquil sub-period 1961:III to 1967:IV, the OLSQ estimate of the offset coefficient drops to .56. The latter estimate is still large compared to those produced by the structural studies.

The remaining discrepancy can be attributed to the sterilization bias. Herring and Marston report a Bundesbank domestic-credit policy reaction function in which domestic credit responds not only to the balance of payments, but also to lagged inflation and to the lagged percentage change in manufacturing orders. If u_t in (1) is serially uncorrelated, the latter two variables are correlated with ΔDC_t but not with u_t, and may be used as instrumental variables for ΔDC_t in calculating a 2SLS estimate of the offset coefficient.[3/] This estimate, reported in Table I, is insignificantly different from zero, and thus is very different from the OLSQ estimate over the same sample period. A formal test, due to Jerry Hausman, shows that the hypothesis that there is no sterilization bias can be definitively rejected. To implement the Hausman test, add to (1) the variable $\hat{\Delta DC}_t$, which is the predicted value from an OLSQ regression of ΔDC_t on the instrumental variables, including the other regressors in (1). The hypothesis of no sterilization bias is equivalent to the hypothesis that the coefficient of $\hat{\Delta DC}_t$ is zero. The result of OLSQ estimation (with standard errors in parentheses) is:

$$(2) \quad CAP_t = .183 - .618 \, \Delta DC_t - .433 \, \Delta R_t^* - .006 \, \Delta Y_t - .840 \, CURR_t$$
$$(.148) \quad (.077) \qquad (.287) \qquad (.020) \qquad (.076)$$

$$+ \ 1.049 \, \Delta S4 + .620 \, \hat{\Delta DC}_t + u_t$$
$$(.478) \qquad (.242)$$

The hypothesis that the coefficient of $\hat{\Delta DC}_t$ in (2) is zero is easily rejected.

The message of this exercise is that reduced-form OLSQ offset estimates should be interpreted with caution. In the case of West Germany, at least, structural offset estimates appear more reliable; and they suggest that the short-run offset to Bundesbank domestic credit policy was rather moderate in the 1960s. These tentative conclusions relate exclusively to the feasibility of sterilization as a short-run or temporary policy. Did the Bundesbank's short-run monetary autonomy afford West Germany any long-run independence from monetary developments abroad? The speculative turbulence of the years 1968-1973 is evidence that it did not.[4/]

II. The Scope for Sterilization under Managed Floating

When the exchange rate floats, the nominal money supply becomes a policy-determined variable which may be set by the Central Bank at any desired level. The freedom from offsetting reserve losses is largely illusory, however, for central banks are usually unwilling to live with the exchange-rate consequences of their monetary decisions. As Charles Kindleberger prophetically observed in 1969, "Along with one more variable there is one more target--the exchange rate."

If foreign- and domestic-currency bonds are perfect substitutes, Central Bank operations involving nonmonetary assets will have no effect on equilibrium exchange rates and interest rates, except, perhaps, in the very short run. As in the case of a rigidly fixed exchange rate, the Central Bank can attain independent exchange-rate and money-stock targets only if it can alter the expected nominal

yield differential between foreign and domestic bonds. On a portfolio-balance view of exchange-rate determination, in which bonds of different currency denomination are imperfect substitutes, debt management may be an independent instrument of exchange-rate policy. (See, for example, William Branson, Lance Girton and Dale Henderson, Peter Kenen, Kouri, and Obstfeld (1980c).)

A number of recent econometric studies conclude that bonds differing in their currency of denomination are not viewed as perfect substitutes by investors even when the bonds are identical in all other respects. (See Cumby and the author (1981b), Craig Hakkio, and Lars Hansen and Robert Hodrick, among others.) Cumby and the author investigate the stochastic properties of weekly time series of the form

$$(3) \quad \varepsilon_{t+1}^{j} = \log(S_{t+1}^{j}) - \log(S_{t}^{j}) - R_{t} + R_{t}^{j}$$

where S_{t}^{j} is the U.S. dollar price of currency j at time t, R_{t} is the one-week Eurodollar interest rate, and R_{t}^{j} is the one-week interest rate paid on Euro-currency deposits denominated in currency j. If dollar bonds and currency-j bonds are perfect substitutes, then, in an efficient asset market, the _ex post_ nominal return differential ε_{t+1}^{j} must be uncorrelated with information available to investors at time t. In fact, lagged values ε_{t}^{j}, ε_{t-1}^{j},... of the _ex post_ excess return do help forecast ε_{t+1}^{j} for all currencies examined. This evidence indicates that ε_{t+1}^{j} is the sum of a white-noise forecast error _and_ a time-varying risk risk premium. The latter separates the expected nominal yield on dollar bonds from that on bonds denominated in currency j.

Of course, the foregoing evidence does not imply that Central Bank financial operations can influence the risk premium in a predictable manner. Even if government securities are outside assets, stochastic models of international asset pricing leave one doubtful that a small country's sterilized intervention operations can have a significant effect on its exchange rate. And a large

country would have to intervene massively to have much impact.[5/]

There is little econometric evidence concerning the effects of sterilized intervention. Regressions of exchange rates on supplies of government-issued interest-bearing debt cannot shed much light on the issue, for an increase in government borrowing may affect the exchange rate by signalling additional future money creation. A more promising approach, adopted by Jeffrey Frankel, is to regress the ex post excess return (3) on financial variables in an attempt to identify the determinants of the risk premium. In tests on U.S.-German data, Frankel could find no financial variables that help in explaining the ex post nominal return differential. This finding is not evidence against the existence of a risk premium; but it does suggest that the static models of international asset pricing underlying the portfolio-balance view may be inadequate. The evidence does not support the proposition that sterilized intervention has been a potent policy tool in recent years.

Footnotes

[1] In these equations, the domestic credit variable is defined as the increase in the net domestic assets of the Bundesbank plus the increase in required reserve holdings by private banks. It is equal to the variable $\Delta NDA + L$ in Neumann. This measure captures the importance of reserve requirement changes as an instrument of monetary management in Germany.

[2] Kouri and Porter argue that the inclusion of additional dummy variables in periods of heavy speculation reduces the bias in OLSQ estimates. In fact, the effect of dummy variables on the estimated offset is quite small for the data set used here.

[3] The inflation rate is the rate of increase in the German WPI. Data are taken from the 1973 Supplement to the IMF's International Financial Statistics. Data on manufacturing orders (in the form of an index) come from the OECD's Historical Statistics.

[4] For a theoretical discussion of sterilization as a long-run policy, see Obstfeld (1980b).

[5] The argument here assumes that the Central Bank's decision to undertake sterilized intervention does not convey to the market new information regarding future monetary growth. Michael Mussa discusses that possibility.

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