The Rate Structure and Capital Movements: a Note on Operation Twist*

Any attempt to employ discretionary monetary policy as an instrument of cyclical control meets the difficulty that, if domestic interest rates are reduced to halt or reverse a recession, one side effect may well be a capital outflow. In certain circumstances this may be acceptable. But at many times, a capital outflow on any scale would be an embarrassment to the authorities. The problem therefore arises as to whether interest rate adjustments desirable for cyclical purposes can be made in a form which limits or discourages the outflow of capital. On the hypothesis, which appears to be widely accepted, that capital movements are primarily functions of relative short-term rates while aggregate demand is a function primarily of long-term rates, a common recommendation is that relatively low rates at long-term should be accompanied by relatively high rates at short-term. This implies that the reduction in long-rates should be carried out by a technique which, at the same time, modifies the rate structure or, more precisely, narrows the long-short differential. One such attempt along these lines was the policy — usually known as Operation " Twist " or Operation " Nudge " — conducted by the U.S. authorities after the 1960-61 recession.[1] This paper briefly re-examines that policy and then attemps to assess its impact on capital flows from the U.S.

1. The Objectives and Techniques of Operation " Twist "

Following the 1960-61 recession in the U.S., the monetary authority attempted to combine monetary ease with the maintenance of short-rates at a level, in relation to rates ruling overseas, which

1 According to BRIMMER (18) the Federal Reserve thought of this as Operation «Nudge».

reduced the rate of capital outflow from the U.S. The proximate objective of the authorities was therefore to " twist " the rate curve: thas is to reduce the long-short differential or yield gap prevailing at any given level of the long rate. The ultimate objective was, by this means, to reduce the rate of capital outflow. Our problem is thus neatly divisible into two elements: the impact of operation " Twist " on the yield gap; and the impact of the policy induced increase in short-rates (over what they would otherwise have been) on capital movements. We begin by examining the first of these elements.

The starting point of this examination must necessarily be the theory of the rate structure. Accordingly we begin with an unavoidably truncated account of the relevant theory on which the literature is extremely extensive.[2]

Assuming rational behaviour and some degree of risk avoidance, the typical portfolio manager will adjust his holdings of financial assets until the expected rate of return (including expected capital gains or losses) on " longs " — plus any risk provision — is equal to the expected rate of return on " shorts ". To give a simple illustration, assume that the total portfolio consists of government debt and call this D_j. Then,

$$D_j \equiv C_j + S_j + L_j$$

where

$C_j \equiv$ demand debt (currency)

$S_j \equiv$ " short " debt

$L_j \equiv$ " long " debt.

Given the value of D_j, the portfolio restriction, the manager now has to choose any two of:

$$X_0 \equiv \frac{C_j}{D_j} \qquad X_1 \equiv \frac{S_j}{D_j} \qquad X_2 \equiv \frac{L_j}{D_j}$$

since $\quad X_0 + X_1 + X_2 \equiv 1$

In this simple example, the problem of the portfolio manager is to choose X_1, X_2 (and hence X_0) so as to maximise utility where utility

is a function of the expected yield on the portfolio and its " riskiness ". It is also clear that, if D_j were to be replaced by W_j ($\equiv$ the total wealth of the portfolio owner) and other assets, for example equities, introduced into the analysis, the approach could readily be generalised to portfolio choices as a whole.

On the basis of this outline we must expect any portfolio owner to choose so that:

(a) X_1 and X_2 are functions of the expected holding period rates on " shorts " and " longs ";

and (b) X_1 and X_2 are functions of the " risk " indices attaching to " shorts " and " longs ".

Now consider the market as a whole. In this case the totality of portfolio managers (including private individuals) must hold government debt in whatever maturity pattern the authorities choose to supply it. On this assumption the market determines not the proportions X_1, X_2, but the rates r_1, r_2. Thus for the market to be in equilibrium we require:

$$\hat{r}_1 = r_2 + \lambda \hat{g}_2 + L \qquad \qquad \dots (1)$$

where

$\hat{r}_1 \equiv$ expected holding period yield on " shorts "

$r_2 \equiv$ yield on " longs "

$\hat{g}_2 \equiv$ expected capital gain on " longs "

$L \equiv$ liquidity premium

$\lambda \equiv$ a parameter reflecting the relative rates of tax on capital gains and coupon income.

In this formulation X_1 and X_2 do not appear explicitly. However, it can easily be shown that L ($\equiv$ the liquidity premium) is, in theory, a function of X_1 and X_2 and the " riskiness " which the market attaches to short and long debts. If we accept the fairly heavy load

of assumptions implicitly enshrined in (1) and we are also prepared to assume that

$$\hat{r}_1 = r_1 \text{ then}$$

$$r_2 - r_1 = - \lambda \hat{g}_2 - L \qquad \qquad \dots (2)$$

is an expression for the yield gap which, recalling that L is a function of X_1, X_2 and their respective " risk " indices can be written:

$$r_2 - r_1 = - \lambda \hat{g}_2 - f(X_1, \Phi_1, X_2, \Phi_2) \qquad \dots (3)$$

where Φ_1, Φ_2 are the respective risk indices.

This relationship, though familiar and useful as a starting point, nevertheless needs to be modified slightly before it can be used as a framework for analysing Federal Reserve actions.

Consider the liquidity premium term. The formulation in (3)[3] implies that the value of L is independent of the distribution of X_1, X_2 between different sectors of the economy. That is it implies that L is invariant with respect to the extent to which X_1, X_2 are held *directly* by the personal and corporate sectors or *indirectly* through financial intermediaries. This is an extremely strong assumption. Typically we may, since intermediaries generally borrow shorter than they lend, expect that the greater the extent of intermediation, the smaller will be L.[4] Introducing a parameter α as an index of intermediation we can now write:

$$r_2 - r_1 = - \lambda \hat{g}_2 - f(\alpha, X_1, X_2, \Phi_1, \Phi_2) \qquad \dots (4)$$

as our yield gap equation.

On the basis of (4) the monetary authority may hope to influence the yield gap by:

(a) changing α: that is the extent of intermediation;

(b) changing X_1, X_2: that is the maturity pattern of the debt by debt policy decision;

(c) changing $\hat{g}_2$: that is modifying interest rate expectations.

Within this framework we can now examine the U.S. monetary authority's operations.

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[3] For a brief statement of the assumptions cf. Rowan and O'Brien (12), and the references there cited.

[4] For a discussion of this point in connection with Regulation « Q » cf. Tobin (19).

2. The Encouragement of Intermediation

In stimulating intermediation, the Federal Reserve operated in a way which not only increased the capacity of the commercial banks to compete with money market assets but also encouraged them to do so.

Under Regulation "Q" the Federal Reserve set the maximum interest rates payable by member banks on time and savings deposits. As money market rates rise towards or above these maxima, funds are typically withdrawn from the banking system and placed directly on the market. This process, on our formulation, would involve a decline in α and should lead, if our analysis is correct, to a rise in the yield gap. Conversely if Regulation "Q" maxima are raised and the banks made able to compete more effectively for funds, α should rise thus reducing the yield gap. Hence it is not surprising that the Federal Reserve took, during 1961-2, three steps designed to promote intermediation. These were:

(a) an increase in Regulation "Q" maxima;

(b) a reduction in member banks' required reserve ratio against time deposits;

and (c) the exemption of the time deposits of foreign governments and certain foreign institutions from Regulation "Q" maxima for a period of 3 years.

Of these steps (a) and (c) manifestly increased the banks' capacity to compete for domestic and certain classes of foreign deposit while (b) by reducing the reserve cost of time deposits provided an additional stimulus for them to do so.

The observed growth in intermediation in the peroid 1961-1964 was considerable. Unfortunately, after a rush to liquidity by households in the most severe stages of downswings, intermediation typically recovers when market rates are low relative to the borrowing rates of institutions in general and banks in particular. Intermediation therefore tends to move anti-cyclically. This makes it impossible to say how far the observed expansion in intermediation reflected the Federal Reserve actions listed above and how far it was a "normal" cyclical phenomenon. What is clear, however, is that the change in intermediation was dramatic as the Table 1 shows.

TABLE 1

PERCENTAGE RATIOS OF SOURCES OF FUNDS RAISED
BY
PRIVATE NON-FINANCIAL SECTORS

Source	1960. II	1961. II	1962. II
Commercial Banks	16.2	23.3	52.0
Commercial Banks *plus* Private Non-Bank Intermediaries	75.6	79.1	107.5
Private Domestic Non-Financial Sectors	13.8	26.7	6.3
Households	28.1	20.4	— 13.4

Source: Data supplied by Federal Reserve System

Of the three dates selected, 1960. II corresponds to the peak of the U.S. cycle: 1961. II to rather less than one quarter after the trough. At the cyclical peak the banks were providing only 16 per cent of private fund raisings and intermediaries as a whole 76 per cent. By 1962. II, after the Federal Reserve actions, the banks were providing 52 per cent and intermediaries as a group 107 per cent while the contribution of private domestic non-financial sectors had fallen to about half its earlier proportion.

To say how far the observed changes in intermediation were due to Federal Reserve action rather than the typical response to cyclical movements in relative rates, we should need a well specified model of fund flows with good coefficient estimates. Such a model does not, at present, exist. Moreover though there undoubtedly were sharp shifts in fund flows, it needs also to be remembered that, as we have defined it in equation (4), α is an index of the relative weight of institutional and non-institutional debt holdings and thus essentially a stock variable. Hence though variation in fund flows may suggest the direction of change in α, it does not quantify it. Additionally we have no estimate of the response of $r_2 - r_1$ ($\equiv$ the yield gap) to changes in α.

For these reasons we can do no more than offer a tentative qualitative judgment to the effect:

(a) that the Federal Reserve sought to influence the rate curve by encouraging intermediation provided

(b) this could be done without weakening the supply of mortgage finance;

(c) that it was successful in doing so and [5]

(d) on this typical assumption that the yield gap is an inverse function of the degree of intermediation;

(e) that its techniques must have had some (non-measurable) influence towards reducing the yield gap.

3. Expectations and Debt Policy

Though its principal actions to promote intermediation were taken in the fourth quarter of 1961, the Federal Reserve had already (February) abandoned the policy of " bills only " by announcing that system open market operations would henceforward include securities outside the short-term area.[6] In this way it attained two objectives.

In the first place its announcement of the new policy, taken together with its stance of continuing ease at long-term may well have had some effect on market expectations and thus on $\hat{g}_2$ in equation (4). This announcement effect may have been the more significant since it took place against a background of FOMC decisions which generally speaking, after August 1960 through to November 1966 implied either a " stable " or " firming " policy. These policies were, however, defined in terms of " money market conditions ", a somewhat eclectic concept dominated in this period by short-term rates.[7] Thus the announcement effect of the new open market policy and other Federal Reserve statements may have offset the effect on expectations of the rise in short rates which began in mid 1961, accelerated in the fourth quarter of the same year and thereafter proceeded fairly steadily through to mid 1963.

In parallel with the Federal Reserve's widening of the range of open market operations, the U.S. Treasury concentrated its borrowing
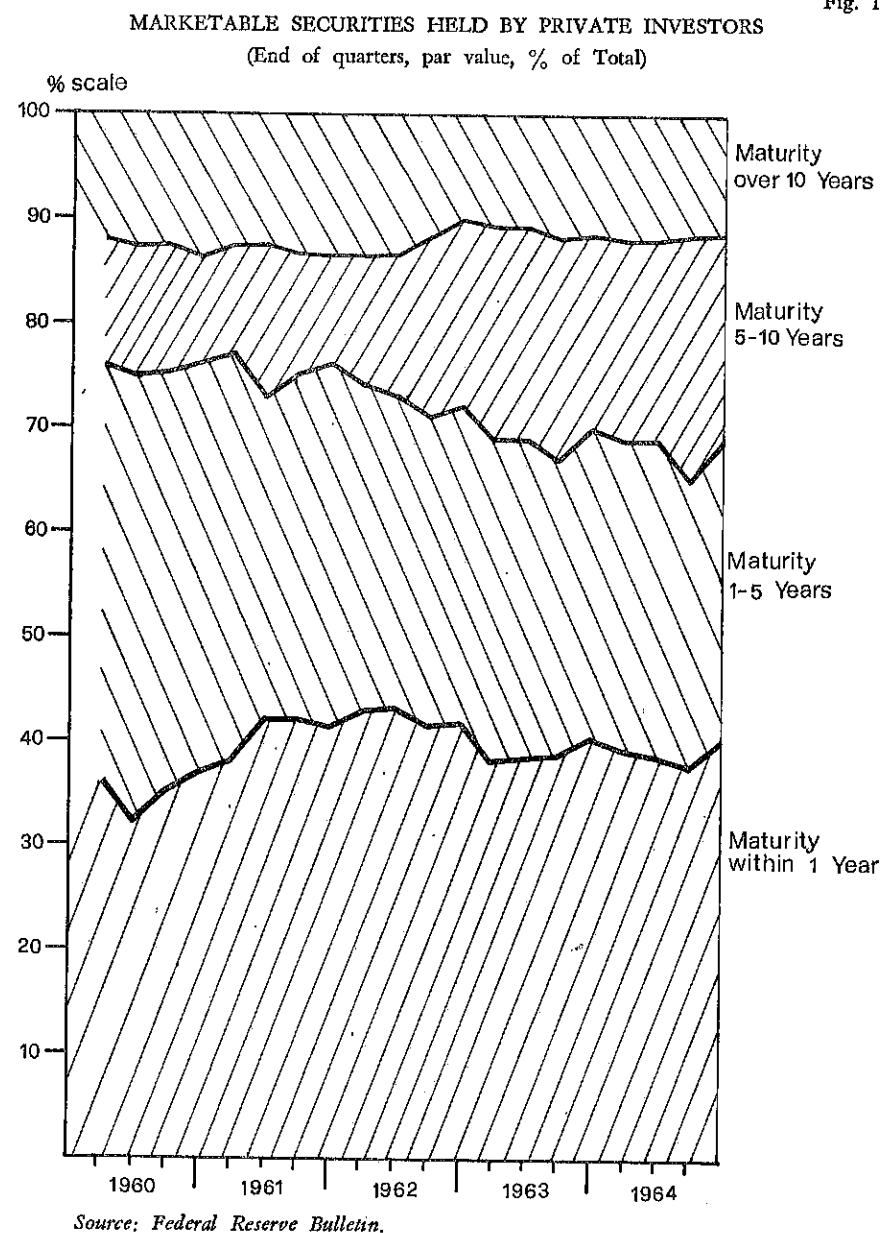
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[5] It can be, and has been, argued that this period constituted something of a triumph for Regulation « Q » in that mortgage rates declined while the flow of funds to the mortgage market was well maintained. This point is made by TOBIN op. cit.

[6] Such securities were purchased but not sold.

[7] This characterisation of « policy periods » is taken from POOLE (23).

as far as possible at the short end of the maturity spectrum. The effect of these operations on the maturity composition of debt held by private sector is plotted in Figure 1.

Fig. I

MARKETABLE SECURITIES HELD BY PRIVATE INVESTORS
(End of quarters, par value, % of Total)

Source: Federal Reserve Bulletin.

The data in this Chart are derived from information published in the *Federal Reserve Bulletin*. As such they make no allowance for the shortening of debt *within* a given maturity band — for example from 5-10 years. Alternative estimates with weighting adjustments to allow for this have been used by Modigliani and Sutch (9 and 10).

The two series tell somewhat different stories. Nevertheless they agree in suggesting that the changes in maturity composition were relatively minor. Typically there was a rise in the proportion of under 1 year debt between 1960 and 1962 after which the ratio declined. The whole of the increase seems, however, to have been accounted for by transfers from the 1-5 year maturity group. Indeed, putting the first two maturity bands together to define a 0-5 year group suggests that the proportion of such debt actually declined. It follows that the U.S. Treasury's operations, when combined with Federal Reserve open market operations, made a comparatively modest, even negligible, impact on the maturity pattern.

In the light of this picture, even though our theory suggests that the liquidity premium should be a function of X_1 and X_2, provided the risk indexes are invariant, it can be argued that we can hardly expect to find any strong evidence of the influence of " debt policy " on the yield gap precisely because " debt policy " was both rather negligible and not maintained.

There remains the possibility that the Federal Reserve's action led to a revision of the " risk indexes " (Φ_1 and Φ_2) and thus modified the yield gap. Unfortunately, except in the case of a one period mean-variance model of the Markowitz-Tobin type, the " risk indexes " are not well defined. In such a model we have, neglecting α, a liquidity term of the form:

$$L(t) = b\{X_2(t)(\sigma^2_{22} - \sigma^2_{12}) + X_1(t)(\sigma^2_{11} - \sigma^2_{12})\}$$

where

$$\sigma^2_{ij} \equiv \text{the ex ante variance (covariance) of the expectations of } \hat{r}_1 \text{ and } \hat{g}_2.$$

Typically we should expect these variances to be functions of time rather than constants and to reflect past errors of expectations. This is the approach followed in Rowan and O'Brien (12) and Gibbs (3). Even if we assume this approach to be correct and that, typically

$\sigma_{22} > \sigma_{11}$, so that $L(t)$ responds positively to X_2, it is not easy to explain why Federal Reserve action should have had an appropriately signed impact on this variance and thus on $L(t)$. The simplest conclusion seems to be that there is no obvious reason to expect Federal Reserve action to have influenced $L(t)$ other than via " debt policy " operating on $X_1(t)$ and $X_2(t)$.

4. The Impact on the Yield Gap

Now that we have given a brief qualitative account of the U.S. authorities operations we need a quantitative estimate of their impact. There are three types of evidence which can be used to form an estimate of this kind. They are:

(a) evidence from econometrically estimated equations specified by reference to the theory of the term structure;

(b) evidence derived from equations which, while relatively empty of economic hypotheses, can be used to forecast either the rate structure or changes in it;

(c) inspection of time series.

Of the three types of evidence, economists have a methodological bias in favour of type (a) since (b) essentially contains little or no economics while (c) inevitably involves the risks inherent in attempting to estimate an unobservable partial derivative from inspection of an observable total derivative. We shall examine all three types of evidence with the object of setting upper and lower limits to the impact of Operation " Twist " and, more ambitiously, giving a " most plausible " estimate of its impact.

Under the heading (a), our first difficulty is that the volume of econometric work on rate structure equations which can be used to explain the yield gap is very considerable. Our account is therefore selective and, being so, to some unknown extent biased. Moreover there are at least two different lines of approach to specification of " expectations-risk avoidance " models. The first of these, exemplified by Modigliani and Sutch (10), Rowan and O'Brien (12) and Gibbs (3), seeks to explain expected interest rates

and thus the expected capital gain (or loss) which we have defined as g_2. The second exemplified by Meiselman (8) and Wallace (16) does not explain expectations but the process, typically of the simple error learning form, by which they are revised. We begin by looking at the former.

As we have seen, the " expectations-risk avoidance " theory yields an equilibrium condition which can be written:

$$r_2 — r_1 = — \lambda \hat{g}_2 — L$$

where:

$$L = f(X_1, X_2, \Phi_1, \Phi_2)$$

To be made operational, this theory requires $\hat{g}_2$, X_1, X_2, Φ_1 and Φ_2 to be defined in terms of observables.

The method adopted to make $\hat{g}_2$ operational generally takes the form of writing:

$$\hat{g}_2(t) = \gamma \{ r_2(t) — \hat{r}_2(t + 1) \}$$

where $\gamma \equiv$ a constant of proportionality.[8]

and $\hat{r}_2(t + 1) — r_2(t) \equiv$ expected change in r_2.

The hypothesis is then extended by writing

$$\hat{r}_2(t + 1) — r_2(t) = f \{ \mathbf{r}_2(t) — r_2^*(t) \}$$

where

$r_2^*(t) \equiv$ the historical expectation of r_2.

Finally

$r_2^*(t)$ is written as a distributed lag of past values of r_1 — as is done by Modigliani and Sutch (10) and Gibbs (3) — or a distributed lag of past values of r_2 — as is done by Rowan and O'Brien (12). Various techniques can be employed to estimate the lag form. The upshot, however, is a relatively simple regression equation involving current and past values of r_1 and r_2.

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8 This procedure is criticized in ROWAN and O'BRIEN (12) who also test an alternative formulation.

The quantification of X_1, X_2 is usually carried out by identifying

$$D = \sum_{j=0}^{j=n} D_j$$ with central government debt and selecting two — or more — maturity classifications to define the X_j with which it is intended to work. Supply functions for the X_j are usually ignored and the X_j are consequently treated as exogenous.[9] Similarly, apart from Gibbs (3) and Rowan and O'Brien (12) the Φ_1 and Φ_2 are taken to be constants. A typical regression equation would therefore be of the form:

$$r_{2(t)} — r_{1(t)} = — a_1(f) \sum_{i=0}^{i=n} w; \ r_1(t — i) + a_2 X_2(t) + a_3 X_3(t) + u(t)$$

where the form of the error term depends upon the approximation selected, in the illustration a distributed lag on r_1, for $r_2(t)$. The process of forming such reduced form equations is fully explained in Modigliani and Sutch (10) and Rowan and O'Brien (12) and (13).

From this approach it is clear that we should obtain, via the estimates of a_2, a_3, direct estimates of the quarterly impact of the " debt policy " operation of the Federal Reserve and the U.S. Treasury. Unfortunately neither Modigliani and Sutch (10), nor any other investigators following a similar approach, have yet succeeded in identifying a systematic and statistically reliable impact of X_2, X_3 on the yield gap. A partial exception to this generalisation is the work of de Leeuw (2) for the Brookings model which yields a small and almost significant transitory effect: that is an almost significant coefficient for $\dfrac{\delta (r_2 — r_1)}{\delta \Delta X_j}$. As a generalisation, however, " expectation-risk avoidance " models have not yet provided any worthwhile evidence of a measurable impact on the yield gap of changes in this proportion of debt outstanding.

As we have seen, Federal Reserve operations may also have influenced expectations quite independently of the influence they must necessarily have exerted through their impact on the short-rate. Since in the Modigliani-Sutch approach expectations are a distributed lag on current and past short rates, any such additional influence

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9 This may well be an important misspecification.

should show up in the error term.[10]   Examination of the residuals from the Modigliani and Sutch equation does not, however, suggest any systematic overprediction of the yield gap such as should occur if Federal Reserve equations were reducing it via means not explicitly accounted for in the model.

The alternative approach is, as we have seen, due to Meiselman (8) with the relevant extension that of Wallace (16). Wallace's estimating equation takes the form: [11]

$$r_1(t+n)t - r_1(t+n)t - 1 = a^n + b^n E(t) + C^n \left[\frac{M_{t\ t+n}}{M_{tt}} - \frac{M_{t-1\ t+n}}{M_{t-1}\ M_{t-1}} \right]$$

where

$r_1(t+n)t$ $\equiv$ the rate on a one (short) period loan expected at time t to rule in period $t+n$;

$E(t)$ $\equiv$ $r_{1tt} - r_{1t(t-1)}$ error of expectations

r_{1tt} $\equiv$ current short rate

$r_{1t(t-1)}$ $\equiv$ rate on a one period loan expected at time $t-1$ to rule in period t

$M'_{t\ t+n}$ $\equiv$ outstanding U.S. government securities at time t which mature at or after time $t+n$.

Wallace's equation, as reported by Telser, relates the forward rates on Federal debt obligations to the maturity composition of the debt. His results indicated that C_n was, in fact, positive and either significant or at the margin of significance. The estimated values of C_n, however, were typically small. This suggested that large changes in maturity patterns would be necessary to exert an appreciable effect upon the rate structure. It is doubtful, therefore, whether Wallace's results seriously weaken our general conclusion that changes in the maturity patterns during the Twist period can, at best, have exerted only a very minor influence.

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5. Forecasting Equations

A simple forecasting equation would explain the change in the long rate (r_2) as a linear function of current and past changes in the short rate. Thus we might write:

$$r_2(t) - r_2(t-1) = a_1 + \sum_{i=0}^{i=n} b_i [r_1(t-i) - r_1(t-i-1)]$$

where the b_i define some unspecified distributed lag function. If all b_i for $i=1,2 \dots n$ are set to zero this reduces to the function used by Hamburger and Latta (4) for the U.S., and Hamburger (22) for the U.K. This is:

$$r_2(t) - r_2(t-1) = a_1 + b_0 [r_1(t) - r_1(t-1)]$$

which can easily be converted into an equation explaining the yield gap as follows:

$$r_2(t) - r_1(t) = a_1 + (b_0 - 1) r(t) - b_0 r_1(t-1) + r_2(t-1)$$

The parameter b_0 has no precise economic significance since no theory of expectations — or anything else — is used to specify it. Nevertheless it appears to be the case that, when the terms in X_j and Φ_j are omitted from them, the apparently more sophisticated forms of equation used by Modigliani and Sutch and Rowan and O'Brien do not perform significantly better than the simple first difference form used by Hamburger and Latta. Implicitly, however, b_0 must summarise the typical response and structure of the market. Hence in so far as Federal Reserve and U.S. Treasury operations exerted a systematic influence b_0 should vary. Since it is methodologically constrained to be a constant, the forecasting errors should provide an approximate indication of the quantitative impact of operation "Twist" — or, putting the matter less strongly — some indication of whether or not operation "Twist" exerted a systematic influence.[12]

In Fig. II the Hamburger-Latta equation has been used to predict the yield gap from mid 1959 through 1966 and the residuals plotted.

Fig. II

YIELD GAP

U.S. Government Long-Term minus 3-months Treasury Bill Rate.
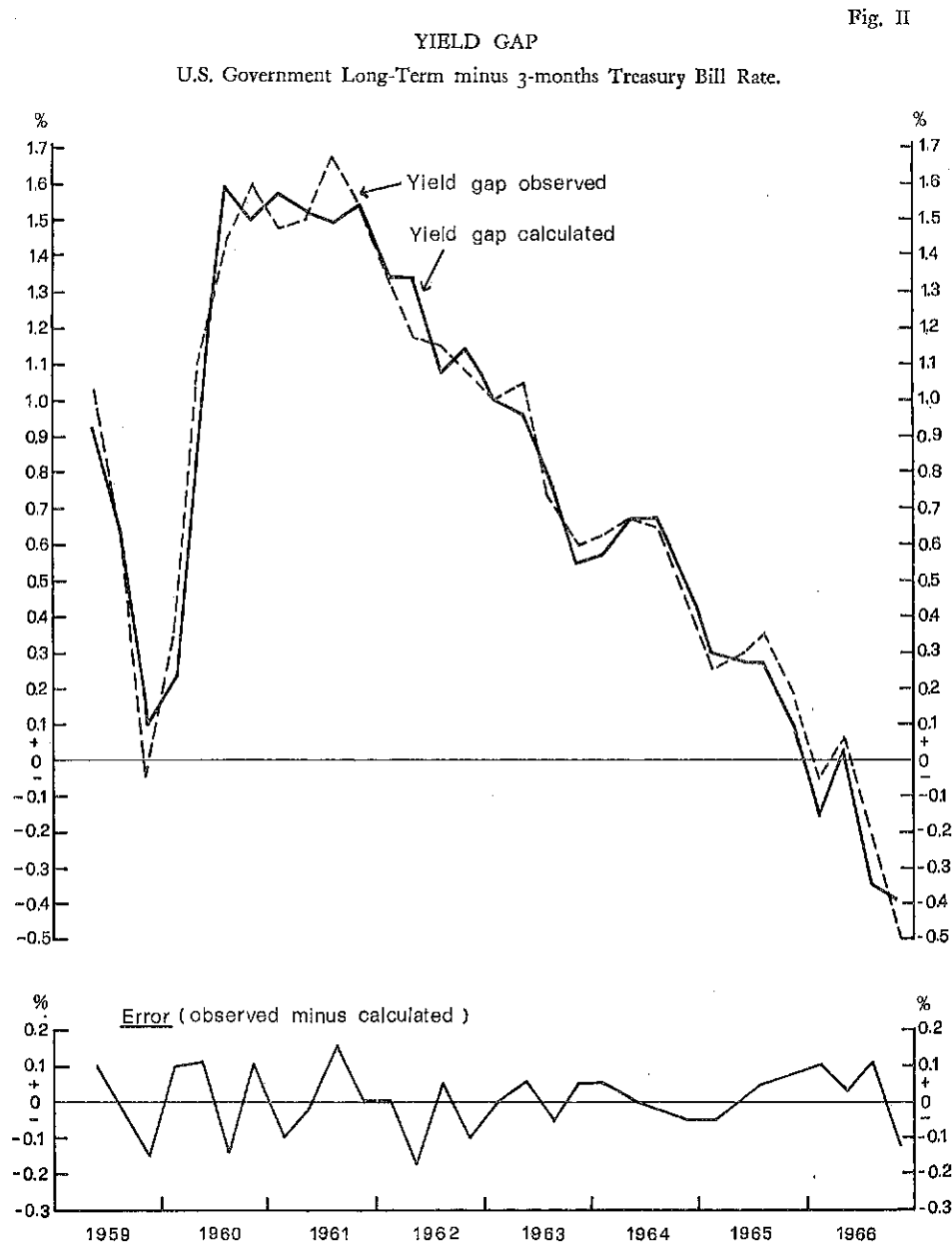
The fit of the Hamburger-Latta equation is impressive. If we date the beginning of operation " Twist" in February 1961 then, through 1963, there is some suggestion that negative residuals dominated. However the suggestion is not a strong one. Moreover, if operation " Twist" did exert an influence it seems to have been quantitatively rather small — that is not more than one tenth of one percentage point — and to have occurred mainly in 1962 and, possibly, the first half of 1961.

We may conclude that the econometric evidence on the impact of operation " Twist" is by no means clear cut. Very tentatively we may argue that the Federal Reserve and the Treasury may, in 1961 and 1962, have reduced the yield differential by some 0.1 per cent over and above whatever influence their policies had upon expectations in so far as these were " captured" — though undefined — by the Hamburger-Latta formulation.

6. Inspection of time Series

While the theoretically specified rate structure equations yield small and unreliable estimates of the impact of operation Twist, the Hamburger-Latta forecasting equation suggests a relatively short-lived impact of the order of 0.1 per cent. This is not inconsistent with an approximate estimate derived from the residuals of the Modigliani-Sutch equation with the X_i term omitted. This very tentative figure

Fig. III

INTEREST RATES
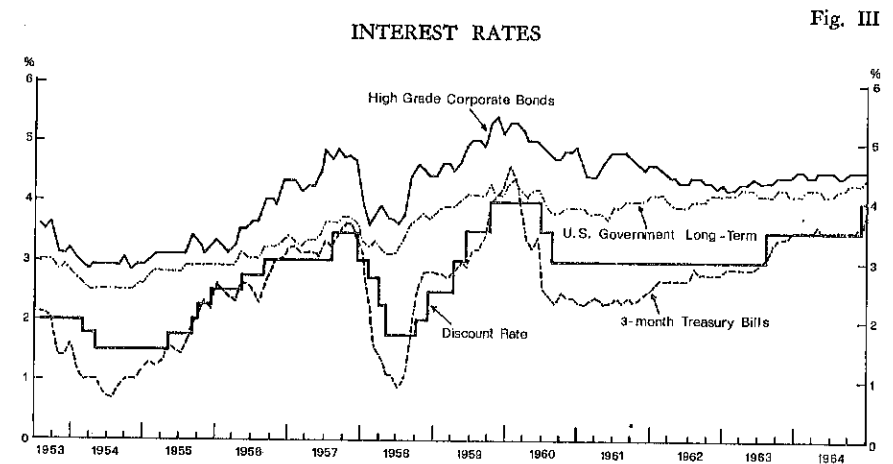
may be set against the (admittedly hard to interpret) evidence of the time series.

The Treasury bill rate fell below 1 per cent in both the 1954 and 1958 cyclical troughs. In the 1961 trough it remained at 2 per cent. If, on the crudest reasoning, the whole of this difference is attributed to operation Twist, then the policy may have added as much as 1 per cent to U.S. short-rates.

If, however, we now look at the *changes* between cyclical peaks and troughs, the picture is somewhat different. From its peak in 1957 to its trough in 1958, the Treasury bill rate fell by about 2.6 per cent. In the corresponding period of 1960-61 the decline was some 2.25 per cent. If we again attribute the whole differences to policy, the impact was of the order of 0.35 per cent.

In the recovery from the 1960-61 U.S. recession, the Treasury Bill rate began to rise in the third quarter of 1961. By the end of 1964, some four years after the cycle trough, the rate had reached 3.8 per cent — a rise of 1.7 per cent. This compares with a rise of 2.5 per cent in the 1954-57 upswing and rather more than 3.4 per cent in the relatively short upswing of 1958-60. This is consistent with the hypothesis that, in 1961, the Treasury bill rate began its rise from a level between (say) 0.5-1.5 per cent higher than it might otherwise have been.

After the 1960-1961 recession, the Treasury bill rate did not peak until the third quarter of 1966. It was then some 0.75 per cent above the 1959-60 peak which, in its turn, was close to 1 per cent above the previous peak. This, again arguing very crudely, is consistent with a policy impact on the short-rates of some 0.5 per cent.

Thus, if we look at the initial levels, recession declines or increases in upswings, the time series suggest that the Treasury bill rate, over the relevant period was (say) between 0.4-1.5 per cent above what previous cycles might have led one to expect. As against this, since 1954, the Treasury bill rate has exhibited an upward trend. Some, unknown, part of this trend was independent of Operation Twist. It therefore seems plausible to argue that Operation Twist, of itself, could not have raised the Treasury bill rate by *more* than one per cent and even this estimate involves attributing nearly the whole of the observed differences to policy without any sound theoretical reason for doing so.

In sum therefore the econometric evidence seems to suggest that Operation Twist may have raised the Treasury bill rate, for a relati-

Fig. IV

INTEREST RATES
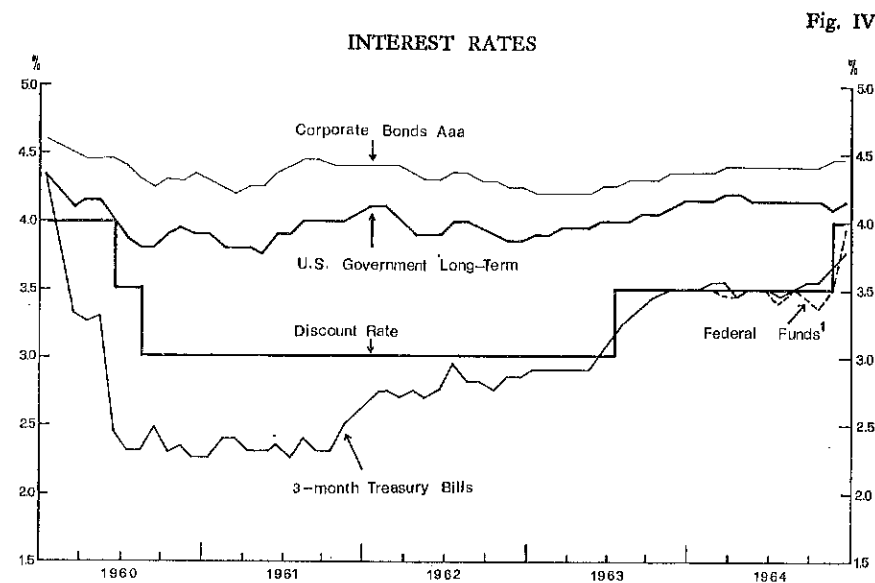
1) Not available before 1964.
Source: Federal Reserve Bulletin.

vely short-period by some 0.1 per cent. Alternatively, rather casual empiricism suggests a longer lived impact amounting, at the maximum, to 1 per cent.

7. The impact on U.S. Capital Flows

Given an upper limit (1 per cent) to the impact of Operation Twist it is, in principle, possible to calculate from a quantified model of U.S. capital flows, the upper limit of the balance of payments effect of Twist. Branson and Hill's (1) study of capital movements in the OECD area provides a framework within which such a calculation can be made. Accordingly we conclude this paper by using Branson and Hill's results to obtain an approximate estimate of the balance of payments impact of Twist.

The starting point of Branson and Hill's study is a stock adjustment model written:

$$\mathbf{K}_t^f - \mathbf{K}_{t-1}^f = \lambda(\mathbf{K}_t^{*f} - \mathbf{K}_{t-1}^f) \equiv \text{capital outflow} \quad \dots (1)$$

where

$K^f \equiv$ claims on foreigners

$K^{*f} \equiv$ desired level of claims on foreigners

The special assumption is then made that $\lambda = 1$: that is actual holdings, K^f, are fully adjusted to planned holdings, K^{*f}, within the period. Hence:

$$K_t^f - K_{t-1}^f = K_t^{*f} - K_{t-1}^{*f} \qquad \dots (2)$$

The general behaviour hypothesis is of the form:

$$K_t^{*f} = W_t \, f(R_t^D, R_t^f, E_t, W_t) \qquad \dots (3)$$

where

$W \equiv$ total wealth

$R^D \equiv$ a vector of domestic interest rates

$R^f \equiv$ a vector of foreign interest rates

$E \equiv$ an index of the riskiness of K^r in comparison with domestic assets.

On this basis we have:

$$K_t^f - K_{t-1}^f = W_t f(R_t^D, R_t^F, E_t, W_t) -$$
$$- W_{t-1} f(R_{t-1}^D, R_{t-1}^f, E_{t-1}, W_{t-1}) \qquad \dots (3)$$

For estimation purposes this relationship is then linearised to yield for the U.S.

$$\Delta K_t^f = a_o + a_1 \Delta(WR^D)_t + a_2 \Delta(WR^f)_t + a_3 \Delta(WMI)_t +$$
$$+ a_4 \Delta(WV^d)_t + a_5 \Delta(WV^f)_t + a_6 \Delta W_t + a_7 \Delta W_t^2 + D \qquad \dots (4)$$

where the new variables are defined as:

$MI \equiv$ the Jaffee-Modigliani credit rationing index

$V^d \equiv$ U.S. income velocity of money

$V^t \equiv$ U.K. income velocity of money

$D \equiv$ U.S. capital account measures taken after 1963.

TABLE 2

MULTIPLIERS FOR CHANGES IN INTEREST RATES AND VELOCITIES

Capital Flow Item	Notation	Interest Rates and Velocities						$ millions		
		RTus	RTuk	RTcn	RED	RBuk	MI	Vus	Vuk	Vcn
Changes in U.S. Short Term Claims on Foreigners	ΔCs	257.6 (3)	−156.1 (2)							
Changes in U.S. Long Term Portfolio Claims on Foreigners	ΔCl	1176.7 (1)			−247.0 (2)		13.6 (1)	222.2 (1)		
Changes in U.S. Short Term Liabilities to Foreigners	ΔLs				−216.6 (2)	−808.5 (2)	79.4 (2)	379.7 (1)	−148.7 (2)	−353.7 (2)
Changes in Longer Term Liabilities to Foreigners	ΔLl	1131.3 (2)			−628.8 (2)				−133.8 (5)	
Errors and Omissions	EO			−345.8 (1)						
Net Financial Capital Movements .	KA	2565.6	−156.1	−345.8	−1092.4	−808.5	93.0	601.9	−282.6	−353.7

Definitions:
RTus = U.S. Treasury bill rate
RTuk = U.K. Treasury bill rate
RTcn = Canadian Treasury bill rate
RED = Eurodollar rate
RBuk = U.K. long-term bond rate
MI = Jaffee-Modigliani credit rationing index
Vus = U.S. income velocity
Vuk = U.K. income velocity
Vcn = Canadian income velocity
KA = $\Delta Cs + \Delta Cl + \Delta Ls + \Delta Ll + EO$

(1) Figures in parentheses below the coefficients indicate the number of quarters over which the coefficient is distributed.

Equations basically of this type are used by Branson and Hill to explain changes in U.S. short and long-term claims on foreigners.[13] An essentially similar approach — but with U.S. wealth (W) replaced by foreign wealth (W^r) — is employed to explain changes in foreign short and long-term claims on the U.S. The summation of these four items plus an estimate of "errors and omissions" provides an equation explaining net financial capital flows.

In the estimates for the U.S. given by Branson and Hill, the scale variables W and W^r are calculated for the end of 1969 values. Given these values it is possible to calculate capital flow multipliers (partial derivatives) for domestic and overseas interest rates, velocities and so on at the constant assumed values of W and W_r. Branson and Hill's estimates, derived after considerable experimentation, yield the Table II which, apart from minor changes in notation, is identical with their Table II-4.

Since the interest rate partials are scaled in terms of percentage point changes then, from the bottom row of the Table, we have, on the assumption that Operation Twist raised the U.S. short-rate by one per cent (our maximum estimate):

$$\frac{\delta\, KA}{\delta RT^{US}} = \$2.57 \text{ billions.}$$

This inflow, as is shown by the figures in brackets below the coefficients, would be concluded after three quarters and by far the greater part of it after two quarters.

The figure must be regarded as an "upper upper" limit of the impact of Operation Twist for not only does it assume the maximum change in RT^{US} but also:

(a) both W and W^r were considerably higher in 1969 than they were on average over 1961-1963 — a circumstance with biasses

$$\frac{\delta KA}{\delta RT^{US}} \text{ upwards;}$$

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[13] The absence of lagged terms in (4) should not mislead the reader. Lags, typically of 1-3 quarters, are in fact inserted by Branson and Hill theoretically in the specifications of the K^*.

and (b) a number of the "independent" variables, notably RT_{CN}, RED, V_{US} and V_{CN} seem certain to respond to changes in RT^{US}. In all probability there would also be some response by RT^{UK} and V_{UK}.

It is difficult to make any particularly convincing numerical adjustments to allow for the items under (b). Branson and Hill themselves suggest that:

$$\frac{\delta RED}{\delta RT^{US}} \simeq 1.0 \qquad \frac{\delta V_{US}}{\delta RT^{US}} \simeq 0.1$$

It is however doubtful whether the first of these corrections is applicable to the full in the Operation Twist period since, at that time, the interdependence between the U.S. money market and the Euro-dollar market was less developed than it subsequently became. On the other hand, since there is typically a very close relation between RT^{US} and RT^{CN} it may be reasonable to assume that:

$$\frac{\delta RT^{CN}}{\delta RT^{US}} \simeq 1.0$$

Taking these assumptions and making a fairly crude correction to the scale variables W and W^r we find that:

$$\frac{dKA}{dRT^{US}} = \alpha \left[\frac{\delta KA}{\delta RT^{US}} + \frac{\delta KA}{\delta RT^{CN}} \cdot \frac{dRT^{CN}}{dRT^{US}} + \frac{\delta KA}{\delta RED} \cdot \frac{dRED}{dRT^{US}} + \frac{\delta KA}{\delta V_{US}} \frac{dV_{US}}{dRT^{US}} \right]$$

where $\alpha \equiv$ the approximate scale correction factor.[14]

Inserting Branson and Hill's estimates of the partial derivatives gives a rough estimate of $\dfrac{dKA}{dRT^{US}} \simeq \$1$ billion.

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[14] This expression is, of course, only an approximation in that a single scale correction is applied to all the terms whereas, strictly speaking, W and W_r require separate correction.

As we have seen this estimate may be biassed downwards —
because we have assumed *both* $\dfrac{dRED}{dRT^{us}}$ and $\dfrac{dRT^{cn}}{dRT^{us}}$ to be unity. On
the other hand it is likely to be biassed upwards since we have
assumed $\dfrac{dRT^{uk}}{dRT^{us}}$ and $\dfrac{dRB^{uk}}{dRT^{us}}$ to be zero when they seem likely to be
positive and thus, since their coefficients are negative, to reduce the
capital inflow. On balance the figure of \$1 billions for the capital
inflow seems likely, if anything, to be upward biassed. It can thus
be regarded as an upper limit — particularly since it assumes our
upper limit figure for the Twist induced change in this Treasury
bill rate.

If we replace our upper estimate of the change in the Treasury
bill rate of 1 per cent by the 0.1 per cent which emerges from an
inspection of the residuals from the rate structure regressions, the
estimated capital inflow is reduced to the trivial figure of \$0.1 billions. Moreover, there is some suggestion in the regression residuals
that the effect of Twist on the Treasury bill rate was not only small
but transitory. Hence, if this is so, the negligible capital inflow
would not only have been completed in three months but subsequently
been reversed.

8. Conclusions

The aim of this paper was to make use of U.S. applied studies to
estimate the impact of Operation Twist on U.S. short-rates and, via
these, on the U.S. capital account.

Unfortunately, despite the considerable range of empirical work
examined, we cannot be at all confident of our estimates. On balance,
our tentative judgment would be that Twist had a relatively small
impact on U.S. short-rates and thus on capital flows.

This conclusion, even if it is correct, does not, of course, imply
that any future attempt to twist the rate structure by debt management
would be unsuccessful. As we have seen, the maturity pattern of the
Federal Debt was changed relatively little in the Twist period.
Moreover, it is always possible that whatever changes there were, were
offset by changes in the maturity pattern of closely competing forms

of debt, for example State and Local Government obligations, about
which information is lacking. It is thus entirely possible that a bolder
and more sustained policy of debt management could appreciably
twist the rate curve and influence capital flows. Unfortunately, the
studies of the rate structure which we possess do not enable us to say
that this is likely to be so nor do they permit us to make any numerical
estimates of the probable impact of alternative debt policies. This
remains an unsettled issue.

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REFERENCES

(1) BRANSON, William H. and HILL, Raymond D. *Capital Movements in the OECD Area*, OECD (December 1971).

(2) DE LEEUW, Frank «A model of financial behavior» *The Brookings Quarterly Econometric Model of the United States*, Edited by J.S. Duesenberry; G. Fromm; L.R. Klein and E. Kuh, Chicago 1965, pages 465-530.

(3) GIBBS, H.J. «The term structure of interest rates: a portfolio selection approach » University of Southampton, 1968. *Unpublished M. Sc.* dissertation.

(4) HAMBURGER, M.J. and LATTA, C.M. «The term structure of interest rates: some additional evidence » *Journal of Money, Credit and Banking*, February 1969, pages 71-83.

(5) HAMBURGER, M.J. and SILBER, W.L. «An empirical study of interest rate determination » *The Review of Economics and Statistics*, August 1969, pages 369-73.

(6) HICKS, J.R. *Value and capital*, Oxford 1946.

(7) MALKIEL, B. *The Term Structure of Interest Rates*, Princeton, 1960.

(8) MEISELMAN, D. *The Term Structure of Interest Rates*, Prentice Hall, 1962.

(9) MODIGLIANI, Franco and SUTCH, Richard «Debt management and the term structure of interest rates: an empirical analysis of recent experience » *The Journal of Political Economy*, supplement: August 1967, pages 569-89.

(10) MODIGLIANI, Franco and SUTCH, Richard «Innovations in interest rate policy» *The American Economic Review*, May 1966, pages 178-97.

(11) MODIGLIANI, Franco and SUTCH, Richard « The term structure of interest rates: a re-examination of the evidence » *Journal of Money, Credit and Banking*, February 1969, pages 112-20.

(12) ROWAN, D.C. and O'BRIEN, R.J. «Expectations, the interest rate structure and debt policy » *The Econometric Study of the United Kingdom*, Edited by K. Hilton and D.F. Heathfield, London, 1970, pages 275-316.

(13) ROWAN, D.C. and O'BRIEN, R.J. «Expectations and the rate structure » *Essays in honor of de Viti de Marco*, Italy, 1970.

(14) SCOTT, R. «Liquidity and the Term Structure of Interest Rates » *Quarterly Journal of Economics*, February 1965.

(15) TELSER, L.G. « The Term Structure of Interest Rates » *Journal of Political Economy*, August 1967.

(16) WALLACE, N. « The Term Structure of Interest Rates and the Maturity Composition of the Federal Debt ». *Unpublished* Doctoral Dissertation: Chicago, 1964.

(17) WALLACE, N. « Comment » *Journal of Political Economy*, August 1967.

(18) BRIMMER, A. « The Political Economy of Money » *paper* delivered to Association of Economic Advisers (December 1971).

(19) TOBIN, J. « Deposit Interest Ceilings as a Monetary Control » *Journal of Money, Credit and Banking* (February, 1970).

(20) TOBIN, J. « Liquidity Preference as Behaviour Towards Risk », *Review of Economic Studies* (February 1958).

(21) TOBIN, J. in *The Theory of the Rate of Interest*, Macmillan, 1966.

(22) HAMBURGER, M.J. « Expectations, long-term interest rates and monetary policy in the United Kingdom » in *Bank of England Quarterly Bulletin*, Volume 11, No. 3, September 1971.

(23) POOLE, W. « Rules of Thumb for Guiding Monetary Policy », in *Open Market Policies and Operating Procedures. Staff Studies* (Federal Reserve System, 1971).