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Policy Choices in an Open Economy: Some Dynamic Considerations

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Decision rules for stabilization policy in an open economy are examined under alternative specifications of the balance of payments. In particular, distinction between interest-sensitive debt capital and equity capital which responds to an activity variable alters the comparative static properties of instrument assignment. Various aspects of dynamic adjustment are further investigated in a context in which time is endogenous and in which the decision process minimizes a criterion function. It is shown that traditional one-to-one pairing of targets and controls may be inferior to assignment of clusters of instruments to some targets for specified time intervals.

Like policy making in general, the formulation of macroeconomic policies in an open economy may be treated as a problem in decision analysis. In a widely used variant of a decision model first developed by Meade (1951) and Tinbergen (1952), the structure of the economy is laid out in terms of a number of important markets, and the conditions under which each market will be in equilibrium are specified. The decision problem then amounts to setting the economic controls in a manner which makes the actual values of key variables like employment and the balance of payments consistent with desired values. The link between state variables and controls is provided by the specified structure of the system, while the intervention of decision makers is governed by a set of rules designed to achieve a unique set of targets.

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Specification of targeted values or, more generally, of a criterion function, serves to introduce a normative element into the analysis by means of which actual values of controlled and noncontrolled variables may be distinguished from their desired values and which has the important consequence of justifying policy intervention even in cases which would, in the traditional definition of the term, be considered equilibrium situations, but in which the set of equilibrium values is inconsistent with perceived objectives.

Much of the important recent work in the analysis of internal-external balance derives its inspiration from the pioneering efforts of Meade (1951), Tinbergen (1952), and Mundell (1968). Within this framework, largely decentralized decisions are made in accordance with rules which assign to each target an instrument which possesses comparative advantage in manipulating that target. When all control variables are so assigned, it can be shown that the resulting policy mix will be stable.[1] The fixity of target values is an integral part of the analysis, for together with the assumption that decision makers hold no preferences—spatial or temporal—as among the chosen objectives, it obviates the necessity of constructing a social preference function.

A further virtue of the approach is that it permits the derivation of important results within an essentially comparative static framework in which decision makers may possess some knowledge about the detailed nature of aggregate functions, but in which they need know little more than the relevant excess demand functions.

The purpose of this paper is twofold. In Section I, in which the effects on assignment stability of alternative specifications of the capital account are examined, it is shown that disaggregation of capital movements into fixed-interest certificates and equities introduces an ambiguity into the decision mechanism, the resolution of which requires more detailed knowledge of the structural coefficients of the system. In Section II the fixed-target–fixed-time model is replaced by a framework in which decision makers minimize a criterion function subject to a set of constraints that explicitly incorporates adjustment speeds of the system and reaction speeds of the policy-making authorities. It is argued that when time horizons are endogenous, one-to-one pairing of control and state variables is not necessarily preferable; a case is sketched in which a decision rule assigns more than a single control variable to a given state variable for some interval of time, after the elapse of which some or all of the controls may be switched to another state variable. The one-to-one mapping of Section I, together with its constant and exogenous time horizon and its fixed set of targets, is seen to be a special case of a more general policy problem.

[1] Other contributions in this area have been made by Fleming (1962), Johnson (1965), Krueger (1965), Sohmen (1967), Jones (1968), Ott and Ott (1968), Patrick (1968), Cooper (1969), and Helliwell (1969).

I. Interest Rates and Income and the Determination of Capital Movements

In the literature on the assignment problem it has been customary in a manner following Mundell (1968) to assume that capital movements are uniquely determined by differentials among countries in interest rates.[2] This procedure is generally justified on the grounds that transactions on capital account which respond to variables other than interest rates are relatively constant in some short-run period, and may thus be ignored in short-run models. The major consequence of this approach is that capital movements are treated as portfolio transactions heavily dominated by claims lying near the short and liquid end of the spectrum, so that the short-term rate of interest becomes the relevant independent variable. By necessity this approach does not, and is not intended to, account for the flow of equity capital. This systematic exclusion from the analysis of certain phenomena is conceptually readily defensible, but the empirical relevance of a policy model that ignores equity flows rests upon verification of the implicit argument that transactions in equities respond to disturbances with greater adjustment lags than do those involving merchandise and services. The arbitrariness of the distinction between so-called short-term and long-term capital movements is underscored by recent empirical evidence that fluctuations in "activity variables" generated in short-term models give rise to statistically significant responses in international equity transactions.[3]

In the following discussion, transactions on capital account are disaggregated into those involving fixed interest-bearing securities that are assumed to respond to variations in rates of interest and into those properly classified as direct investment. The latter are assumed to vary with expected rates of return on investment, so that the direct investment inflow (D) is positively related to the excess of the domestic over the foreign expected real rate of return:[4]

$$D = D(r_d - r_f), \qquad D' > 0. \tag{1}$$

[2] See, among others, Krueger (1965), Sohmen (1967), Mundell (1968), Ott and Ott (1968), and Cooper (1969).

[3] Income or activity variables have been built into theoretical models of internal-external balance by Johnson (1965), Jones (1968), Patrick (1968), and Helliwell (1969); and in quarterly models of Canada and France, respectively, Rhomberg (1964) and Arndt (1970) have found some empirical evidence in support of the hypothesis that direct investment responds to variables other than the nominal rate of interest. In his recent study of the quarterly U.S. balance of payments, Prachowny (1969) shows that the industrial production index swamps the interest differential in a regression determining the outflow of direct investment capital. Moreover, his tests do not provide significant criteria for preferring the interest variable to the activity variable as principal determinant of equity capital movements.

[4] Relative rates of return must be corrected for relative risk factors; as a firm's investment in a foreign country rises in relation to its total investments, the growing concentration that is implied by further acquisition of claims in that country will be reflected in a rising risk coefficient.

With the introduction of equity transactions, the capital account is exposed to an additional source of variation, but it remains to be seen whether this alters the fundamental assignment rule according to which monetary policy serves best the external goal, and fiscal policy the internal. In figure 1, the A_0A_0-line is the familiar linearized internal-balance schedule, its negative slope indicating that the desired internal equilibrium can be maintained in the face of a cut in government expenditures (G) only by an expansion in the stock of money (H). Similarly, the foreign-balance schedule Z_0Z_0 has negative slope because a surplus in the trade balance occasioned by a reduction in the government's outlays must be compensated by a monetary expansion which, by lowering domestic interest rates, increases the outflow of interest-sensitive capital. The comparative advantage with which monetary policy affects the external balance is reflected in the steeper slope of the Z_0Z_0-schedule.

The two functions divide the quadrant into four zones, with the zones above A_0A_0 characterized by excess demand in domestic markets, while the zones above Z_0Z_0 represent an excess of payments over receipts in the external accounts. In each zone the short arrows indicate the direction in which the control variables must be moved in order to return the system from points in that zone to the equilibrium intersection between the two schedules. Consider, thus, the point Q at which the economy suffers from recession and from a payments deficit. In following the

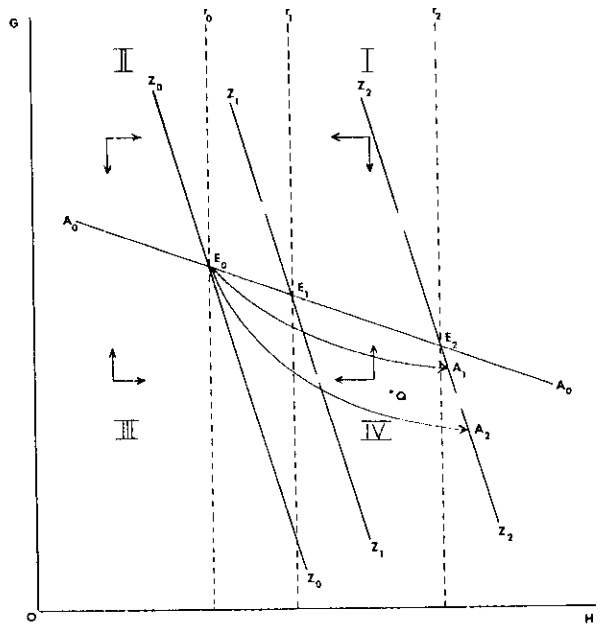

FIG. 1.—Internal (AA) and external (ZZ) balance for several relative expected rates of return (r) on equity investment.

prescribed program, the authorities increase government expenditures in order to increase domestic employment and income, while raising the degree of monetary stringency in order to attract the interest-sensitive foreign capital required to offset the worsening trade balance.[5]

As it is the objective of government during periods of recession to uplift the private sector's economic confidence, the fiscal expansion, if successful, improves the profit expectations of investors, and according to the preceding discussion, a relative increase in profit expectations tends to raise the inflow of investment capital. The effect of this inflow is to shift the foreign-balance schedule to the right and thus to change the extent of fiscal expansion and monetary laxity required for the attainment of joint balance. As the external-balance schedule is displaced in the direction of Z_1Z_1, the magnitude of the monetary contraction which will restore joint balance (now at E_1) is diminished, and the less stringent monetary requirements in turn have the effect of decreasing the magnitude of the necessary fiscal expansion.

While the movement, therefore, of the external-balance schedule to Z_1Z_1 alters the policy response, it does not affect its direction because the moving point Q is assumed to remain in zone IV. When Z_2Z_2 is the new foreign-balance schedule, however, the policy mix which achieves the new equilibrium combines fiscal expansion not with monetary contraction but with monetary expansion. If the authorities respond solely to observed excess demand conditions at Q without any knowledge of the shape of the functions or of the shift parameters in their arguments, they will initiate a monetary contraction, and the resulting inflow of interest-sensitive capital will, when added to the equity capital inflow, hasten the development of a balance-of-payments surplus. At the same time, the monetary stringency tends to slow the rate of growth of internal demand, though it is not possible without detailed dynamic specifications to judge the severity of this retardation. Further, although the crossover into a new quadrant and the consequent reversal in the required direction of one of the controls increases the presumption that equilibrium will not be achieved without oscillations, it is again not possible to ascertain from the information given whether and to what extent the stability of the system is endangered. It can be concluded, however, that the absence of some knowledge of the shape of functions and of shift parameters[6] diminishes the probability of a direct approach to equilibrium.[7]

[5] The means by which increased government expenditures are financed is of importance. If deficit finance is the chosen vehicle, the very act of increasing G will, in the absence of infinitely elastic international capital lead to an increase in the domestic interest rate, implying that a continuing deficit financed through open-market sales and thus a growing supply of bonds will put continuing pressure on the rate of interest.

[6] As we shall see below, not only the ZZ-schedule, but the AA-schedule as well, is likely to shift as a consequence of investment capital inflows.

[7] The shift parameter can represent a number of forces which would tend to shift the

The Expected Rate of Return and Policy Surrogates

A current reading on the distribution of private-sector profit expectations would represent an important input into the policy decision process. On the whole, this information is rarely available, and in its absence a number of surrogates have been proposed, among which the use of an "activity" variable has gained prominence.[8] In the present section a difficulty in the use of income or related variables is examined.[9]

Where an activity variable has been employed, the capital account has frequently been specified as follows:

$$K = K(i, Y), \qquad K_y > 0, \qquad K_i > 0, \tag{2}$$

where K is the total capital inflow and K_y and K_i the partial derivatives relating equity and interest-sensitive capital flows, respectively, to their principal determining variables. A noteworthy characteristic of equation (2) is the sign of K_y, which rests on the assumption that income is a highly substitutable proxy for the expected rate of return (r), so that variations in $(r_d - r_f)$ will be adequately reflected by variations in $(Y_d - Y_f)$. If, as in some variants of the accelerator model, profit expectations are determined by current economic activity or by expected future changes in activity which are directly related to current activity, the covariation between current income and expected profit differentials is probably substantial. But if, as is by no means impossible, expectations concerning future returns lead or lag variations in current activity, observed inflows of equity capital will have no uniformly positive relationship to current activity.

ZZ-function about. One of these is speculative expectations regarding the authorities' ability to maintain the given exchange rate. In a dynamic context, speculators' expectations can be related to the rate at which the nation's stock of foreign exchange reserves is being depleted as the policy measures taken at Q propel the system toward the ZZ-curve. Suppose that speculative capital outflows (K_s) are related to the time rate of decrease in reserves, $K_s = g(dR/dt)$. While the system is off the ZZ-schedule, reserves are declining, and the greater the delay in returning to external balance, the greater the total loss in reserves. The proportional reserve loss per unit of time is thus inversely related to the rate at which Q is pushed toward ZZ, and the slower that corrective movement, the greater the probability that speculative outflows of capital will shift the foreign-balance schedule to the left, thus compounding the requirement of monetary stringency. Introduction into the analysis of expectational changes therefore can severely undermine the all-important constancy of the market-balance functions. The last point applies equally to an economy facing an excess demand-cum-deficit situation, as in zone I. As it relates to the stability of the foreign-balance function, the relative rise in domestic prices brought about by the excess demand in goods markets tends to shift Z_0Z_0 to the left.

[8] The principal studies which have used activity variables are those of Johnson (1965), Jones (1968), Patrick (1968), Helliwell (1969), and Prachowny (1969).

[9] In a cogent analysis, Ablin (1968) has addressed himself to the proper specification of the income variable, considering among others the trend rate, the level, and the current rate of change of income.

The preceding is not a brief against income as a proxy for the expected return, but against the strong hypothesis $K_y > 0$. In the following, that hypothesis is replaced with the less restrictive hypothesis $K_y \gtrless 0$.[10]

The consequences of the preceding analysis for correct assignment may be exposed with the aid of the following model, important features of which are the specification of the capital account and of the government's budget constraint. The supply of national output is assumed infinitely elastic, assuring a constant price level, and the exchange rate is assumed fixed:

$$E(Y, i) + F(Y, i) + G - Y = 0, \qquad 1 > E_y > 0, E_i < 0, \quad F_y < 0, F_i > 0; \tag{3}$$

$$F(Y, i) + K(Y, i) - B = 0, \qquad K_y \gtrless 0, K_i > 0; \tag{4}$$

$$L(Y, i) - H = 0, \qquad L_y > 0, L_i < 0; \tag{5}$$

$$V(Y, i) - S = 0, \qquad V_y > 0, V_i > 0; \tag{6}$$

$$G = \Delta H + \Delta S, \tag{7}$$

where Y = national income, E = private expenditure, F = trade balance surplus, G = government expenditure, B = balance of payments, K = net capital inflow, L = demand for money, H = supply of money, V = demand for government securities, S = supply of government securities, and i = yield on government securities.

Equations (3), (5), and (6) describe the goods, money, and securities markets, respectively, and equation (7) gives the government's budget constraint under the assumption that all current expenditures are financed by supplying money or by supplying bonds. Under regimes of fixed

[10] Large movements of American funds into Canadian extractive industries during the fifties occurred in anticipation of future growth in the United States which was widely expected to create shortages in domestically produced raw materials. While such inflows tend to stimulate activity in the recipient economy, they may be inversely related to the relative rate of activity there, being determined instead by the relative expected profitability of investment in that country. In analyzing these flows into Canada, Wonnacott (1965) has differentiated between the "relative-cycle hypothesis," according to which equity capital inflows are positively correlated with relative current income expansion, and the "exporter's cycle hypothesis," according to which capital exports are positively correlated with a relative expansion in a country's income. The difficulties associated with the use of activity variables as proxies are compounded by the lack of synchronization of business cycles between countries. The strong hypothesis, $K_y > 0$, has the disadvantage of seeming to impart to the adjustment mechanism an inherent instability. Variations in income are the cause of variations in saving and investment. In case of specification (1), a flow of equity capital between two countries will have the effect of narrowing for any given level of world investment the gap between rates of return in the two countries, much as the flow of portfolio capital is assumed to eliminate gaps between national interest rates. Under the strong income hypothesis, on the other hand, a capital inflow occasioned by a country's relatively strong activity may widen still further the activity gap between the two countries, thus creating the incentive for more capital transfers in a process which appears to be self-perpetuating rather than self-limiting.

exchange rates, the stock of official reserves will increase and decrease with surpluses and deficits in the balance of payments, which raises the possibility that actual reserve changes ($dR/dt = B$) may be inconsistent with desired reserves. In what follows, we shall assume that the authorities hold no specific reserve goals and that the domestic monetary effects of variations in reserve holdings are automatically neutralized.

The relevant equations of change are obtained by differentiation of equations (3), (4), and (5):

$$(1 - E_y - F_y)\,dY - (E_i + F_i)\,di = dG, \tag{8}$$

$$-(F_y + K_y)\,dY - (F_i + K_i)\,di + dB = 0, \tag{9}$$

$$L_y\,dY + L_i\,di = dH. \tag{10}$$

The determinant of the system is given by

$$\Delta = -(1 - E_y - F_y)L_i - (E_i + F_i)L_y, \tag{11}$$

and a sufficient condition for a positive determinant is that the propensity of the private sector to spend (E_y) be less than unity plus the propensity of the trade balance to worsen with an increase in income (F_y) and that the effect of variations in the rate of interest on expenditure be greater than its effect on the trade balance.

The object of the following manipulations is to discover the effects of monetary and fiscal operations on the variables Y, i, and B and to compare the results for $K_y > 0$ with those for $K_y < 0$.

$K_y > 0$:

$$\frac{dY}{dG} = -\frac{1}{\Delta}\left[L_i + (E_i + F_i)\frac{dH}{dG}\right] > 0, \tag{12}$$

$$\frac{dY}{dH} = -\frac{1}{\Delta}(E_i + F_i) > 0, \tag{13}$$

$$\frac{di}{dG} = \frac{1}{\Delta}\left[L_y - (1 - E_y - F_y)\frac{dH}{dG}\right] \gtrless 0, \tag{14}$$

$$\frac{di}{dH} = -\frac{1}{\Delta}(1 - E_y - F_y) < 0, \tag{15}$$

$$\frac{dB}{dG} = \frac{1}{\Delta}\left\{L_y(F_i + K_i) - L_i(F_y + K_y) - [(F_i + K_i)(1 - E_y - F_y) + (F_y + K_y)(E_i + F_i)]\frac{dH}{dG}\right\} \gtrless 0, \tag{16}$$

$$\frac{dB}{dH} = -\frac{1}{\Delta}[(F_i + K_i)(1 - E_y - F_y) + (F_y + K_y)(E_i + F_i)] \gtrless 0. \tag{17}$$

An injection of government expenditure increases national income, a portion ($L_y\,dY$) of the increased income being devoted by the public to augmentation of its holdings of domestic money. The increased demand for money pushes up the rate of interest if $dH = 0$, and it will raise the rate of interest even when $dH/dG = 1$, unless $(1 - E_y - F_y) \geq L_y$.[11] The balance of payments may improve or deteriorate as a consequence of official intervention. A monetary expansion will bring about an unequivocal deterioration in the balance of payments if $(F_y + K_y) < 0$. If $(F_y + K_y)$ is positive, and if, as before, we assume that $(E_i + F_i) < 0$, the condition for balance-of-payments deterioration becomes

$$\frac{(F_i + K_i)}{(E_i + F_i)} < -\frac{(F_y + K_y)}{(1 - E_y - F_y)}. \tag{18}$$

The effects on the balance of payments of fiscal expansion are governed by the manner of financing the government's expenditures. When $dH/dG = 0$, a sufficient condition for payments improvement is $(F_y + K_y) > 0$, whereas for $dH/dG = 1$, the balance of payments will improve if,

$$[(L_y + E_y + F_y - 1)(F_i + K_i) - (L_i + E_i + F_i)(F_y + K_y)] > 0. \tag{19}$$

$K_y < 0$:

Expression $(F_y + K_y)$ is now always negative so that income-sensitive capital flows can no longer be counted on to offset developments in the trade balance. A monetary expansion, which could in the previous case improve or worsen the balance of payments, now brings about an un-

[11] According to the budget constraint (7), government expenditure, dG, is to be financed either by money creation or by bond creation. When $dH = 0$, and assuming that initially $G = 0$, an increase in the rate of interest as given by equation (14) would be expected simply as the result of the greater supply of bonds. This has, among other things, important implications for the speed with which the rate of interest adjusts to its new level. Moreover, if the increase in government expenditure, and thus in bond supply, is required to maintain income at its desired higher level, a continuing budget deficit requires continuing additions to the outstanding stock of bonds, implying a sustained upward drift in the rate of interest. The majority of short-term models do not specify a government budget constraint (but see, for example, Ott and Ott [1968]). Under appropriate assumptions, the small-country model does not suffer from this weakness if additional supplies of bonds can be sold to the rest of the world at externally determined rates of interest. But for such a country a continuing budget deficit gives rise to a steadily rising international indebtedness, even while the capital imports, which improve the capital account, provide steady additions to the money stock. For a large country, the argument can be salvaged by the assumption that additional creation of bonds is so small relative to the outstanding stock that its effects are negligible. This assumption is analogous to assuming that the impact on the capital stock of new investment is negligible.

equivocal deterioration in payments. A budgetary expansion (with $dH/dG = 0$) worsens the balance of payments if

$$\frac{(F_i + K_i)}{L_i} > \frac{(F_y + K_y)}{L_y}. \tag{20}$$

Moreover, the payments balance deteriorates when, along with condition (20), government expenditure is accompanied by money creation.

Income-sensitive Capital and Domestic Economic Activity

The movement of international capital has important consequences for the balance of payments and thus becomes, as we have seen, a critical object of the policy makers' attention. Whether official interest extends to the domestic effects of foreign investment depends upon adjustment speeds. On the assumption that any period that is long enough to accommodate trade balance adjustments and the manipulation of such cumbersome instruments as fiscal policy is probably long enough to enable private decision makers to formulate and execute investment decisions, we consider in this section some domestic implications of direct investment flows.[12]

The inflow of investment capital, which has the effect in figure 1 of shifting the external-balance schedule to the right, supplements the pool of domestic savings and adds to the demand for resources. If idle resources and raw materials exist domestically, the increased demand for these will serve the useful purpose of pushing home income and employment to higher levels. In short, the AA-schedule will move down, implying that the fiscal stimulus needed for the achievement of internal balance has been reduced by the capital inflow, which plays a role similar to government expenditures in generating new demand.[13]

As the internal-balance schedule moves down, its points of intersection with the displaced foreign-balance schedule trace out the new equilibria

[12] For a country as large as the United States, the internal effects of these flows are probably quite small, as are also the repercussions on domestic monetary conditions of interest-sensitive capital flows. But for most other countries, characterized as they are by substantial openness both on current and on capital account, the domestic consequences of changes on capital account can be critical. Relatively large inflows that do not merely replace domestic investment may imply $E_y > 1$, a development that has important implications for the stability of the system.

[13] The stimuli will not be identical in all respects because the composition of GNP, which may be a social goal in itself, will be affected differently. That composition will be affected not only as between the private and public sectors or as between domestic and foreign ownership, but also as between the current and future current-account balance. When foreign direct investment takes place in the context of relatively high utilization of capacity—which is not the situation at Q—the trade balance is affected more immediately as the capital import gives rise to a merchandise import. If it is the direct investment inflow rather than an interest-induced inflow of capital that "finances" the emerging trade deficit, the schedule of future repayments is likely to vary accordingly.

toward which it is the objective of policy to push the system. The joint movement of the two functions will thus move the equilibrium in the direction indicated by the two heavy arrows A_1 and A_2, and in the aftermath of these shifts the actual location of the system (at some point similar to Q) may cross over into any of the other quadrants. The domestic repercussions of the capital inflow must be sufficiently great relative to total domestic activity to bring about significant displacements of the internal-balance schedule, but such displacement, even if small, begins to weigh more heavily as the equilibrium is approached.

The Stability of an Assignment

A policy assignment is said to be correct when instruments and targets are paired in a manner that exploits the comparative advantage of every instrument. To evaluate the relative effectiveness of monetary and fiscal tools and the stability of assignments in light of the foregoing discussion, figure 2 represents the essential features of the model, with balance in the goods and money markets indicated along XX and LL, respectively, and equilibrium in the balance of payments given along the BB-schedule. Schedule B_1B_1 reproduces the standard Mundellian case, while schedule B_2B_2 is one in which a strong positive relationship between income and equity inflows produces a negative slope.

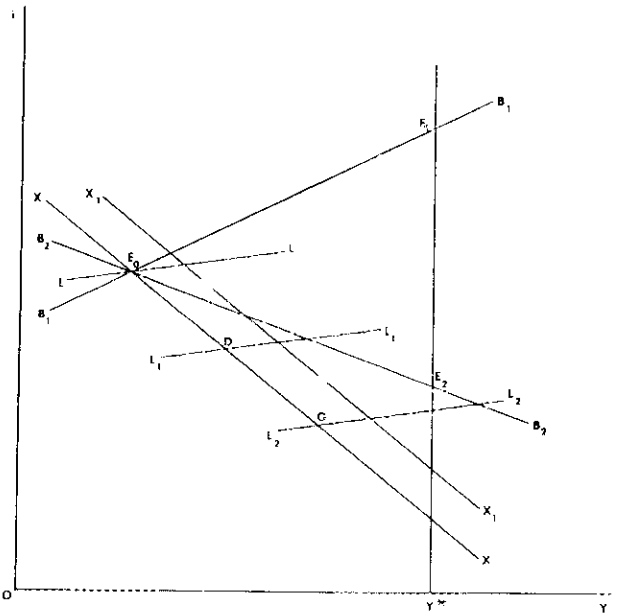

FIG. 2.—Instrument assignments and adjustment under alternative specifications of the capital account of the balance of payments.

It is assumed that income adjusts to excess demand in the goods market and that the rate of interest adjusts to excess demand in the money market, that is,[14]

$$\frac{dY}{dt} = k_1 X(Y, i), \qquad k_1' > 0, \tag{21}$$

$$\frac{di}{dt} = k_2 L(Y, i), \qquad k_2' > 0. \tag{22}$$

The system will exhibit stability if

$$\begin{vmatrix} k_1 X_y - \lambda & k_1 X_i \\ k_2 L_y & k_2 L_i - \lambda \end{vmatrix} = 0,$$

and stability is assured whenever $X_y < 0$; and for $X_y > 0$, the system will be stable provided that $-X_i/X_y > -L_i/L_y$ and $k_1 X_y < -k_2 L_i$.

According to the principle of effective market classification, the authorities adjust government expenditures in accordance with deviations of actual from target levels of income, and the money stock in accordance with deviations of actual from target values of the balance of payments, that is,

$$\frac{dG}{dt} = h_1(Y^* - Y), \qquad h_1' > 0, \tag{23}$$

$$\frac{dH}{dt} = -h_2(B^* - B), \qquad h_2' > 0. \tag{24}$$

Policy mixes that are consistent with these decision rules will achieve the stated objectives in both cases illustrated in the diagram, and other possibilities involving different relative slopes of the three functions may be similarly analyzed. Schedule B_1B_1 obtains whenever $K_y \leq 0$, and in order to reach the new equilibrium indicated by E_1 on B_1B_1, a budgetary expansion paired with a monetary contraction is required to shift XX and LL until they intersect in E_1. The assignment is stable.

But suppose that decision makers have no knowledge of the slopes of the functions. Their policy responses as defined by (23) and (24) are strictly to deviations between actual and desired values of income and of the balance of payments. At E_0 government expenditure shifts XX to the right. As X_1X_1 shows, this leads to a higher rate of interest and to a payments deficit if B_1B_1 rules, but to a surplus if B_2B_2 rules. To these payments imbalances the authorities respond with increased monetary stringency in the first case and greater laxity in the second case. At point D, the same fiscal expansion produces a payments deficit in both cases,

[14] Under a fixed exchange rate, the level of official reserves adjusts to excess demand in the foreign exchange market. The domestic repercussions of that adjustment are assumed to be neutralized.

and in both the monetary controls are tightened. It is now apparent that the resulting increase in the rate of interest will be consistent with the final equilibrium rate if B_1B_1 rules, but not otherwise. In light of the ultimately lower rate of interest at E_2, the direction of monetary policy initiated at point D will at some other stage have to be reversed.[15]

The implications of these results may be briefly stated. First, if decision rules (23) and (24) are adhered to, the assignment will be stable in the comparative static sense. Second, the effect of reversals in the direction of monetary policy on dynamic stability cannot be ascertained without additional specification, and thus it cannot be determined whether such reversals increase the likelihood of oscillation around equilibrium. Third, since monetary stringency reduces the increase in income and employment associated with a given fiscal expansion, the total time interval required to achieve the desired goals is probably greater than it would have been had the authorities been aware of the downward slope of BB and thus expanded the money stock at the time of the fiscal expansion. Fourth, while reverse pairing is unstable for B_1B_1, it will be stable for B_2B_2. At points E_0 and D, a monetary expansion directed at internal balance generates a payments deficit that is removable by a fiscal expansion. The fiscal policy must be expansionary due to the dominance of favorable capital account effects. Thus, the reverse assignment is stable only if the authorities do not respond to the incipient trade deficit with the traditional budgetary contraction, and this assumes some knowledge of the shape of the functions.

The problem is more complex at G. Suppose the authorities react to the internal imbalance with a monetary expansion and to the external deficit with a fiscal injection. This raises the possibility of an intersection of XX and LL beyond the targeted level of income and, if Y^* indicates full employment, presents the authorities with an inflation/deficit situation. What happens at that point cannot be determined with the information given, for the changing domestic price level will shift all the functions.[16]

While the principle of effective market classification thus provides stable guidelines for policy action, the case of B_2B_2 demonstrates that such assignments are not unique in their stability. Indeed, the principle may generate a more roundabout and slower approach to equilibrium,

[15] Note that with G as the starting point, the ultimate requirement in both cases is a rise in the rate of interest from its initial level.

[16] A situation not shown in the figure, but one which is nevertheless of some interest, is that in which the slopes of the XX- and BB-schedules are reversed, making the latter steeper than the former. It can readily be shown that assignment according to rules (23) and (24) is unstable. If, on the other hand, the decision rules are less narrowly defined, stipulating simply that the fiscal instrument be paired with internal balance and the monetary instrument with external balance, then a fiscal contraction together with a monetary expansion can lead the system to the desired equilibrium. This, once again, would necessitate some knowledge of the structure of the system.

particularly when h_1 is very small. In that event, delays in the initiation of fiscal measures, combined with the pressing urgency which authorities may attach to achievement of the internal target, may induce them to assign monetary policy to the internal goal. As we have seen, such action contravenes (23) and (24), but it may nevertheless be stable. We turn to problems of this sort in the next section.

II. Some Aspects of a Dynamic Policy Model

Up to this point, policy makers have been assumed to hold uniform time preferences; no attempt was made to evaluate alternative time horizons in terms of their social desirability. The time horizon was exogenously determined. The present section examines some implications of replacing the earlier fixed-time model with a framework in which time itself becomes a target. When the time horizon is endogenous, the distinction between controlled and noncontrolled variables is blurred, and incompatibility among objectives may be as much a temporal as a spatial phenomenon. The effectiveness and comparative advantage of an instrument requires measurement in time-efficiency units as much as in terms of its total impact.

Suppose that in the following two-by-two model state variables are related linearly to controls:

$$x_{1t} = \sum_{t-\tau} \beta_{1it} a_{it} + u_{1t}, \qquad i = 1, 2; \tau = 0, 1, \ldots, \tag{25a}$$

$$x_{2t} = -\sum_{t-\tau} \beta_{2it} a_{it} + u_{2t}, \tag{25b}$$

where the x_{it} are the current values of state variables, the a_{it} current values of control variables, and the u_{it} represent the effect of "other" factors. Equations (25) may be expressed in convenient vector notation as

$$x_t = Ba_t + u_t, \tag{26}$$

where it should be noted that the first term on the right-hand side incorporates the lagged effects of policy actions. Positive values of the control variables are assumed to increase x_1 but to decrease x_2, the implication being that in cases in which higher values of both target variables are preferred, the effect of the constraints (25) is to generate a conflict situation.

In place of the assumption of Section I that the decision makers pursue fixed targets, we suppose that they seek to minimize the following loss function:

$$L(x, a) = \int_0^T \phi(t) F(x_1 - x_1^*, x_2 - x_2^*)\, dt, \tag{27}$$

where the functional is defined over the planning horizon T; $\phi(t)$ is a time-discounting function; and the x_i^* are the desired values of the state variables.[17] The integrand is assumed to be a quadratic function. In order to simplify the exposition and without loss of generality, we replace (27) with its discrete analogue, which is expressed in terms of its expectation to take account of uncertainty:[18]

$$E[L(x, a)] = E\left[\omega \sum_t \theta_{1t}(x_{1t} - x_1^*)^2 + (1 - \omega) \sum_t \theta_{2t}(x_{2t} - x_2^*)^2\right], \qquad (28)$$

where ω indicates the relative importance to policy makers of achieving the first target. In the process of minimization of (28) subject to constraints (25), time enters once through the lagged impact of policy instruments on targets and again through the cumulative effect over some time horizon of the selected policies on the loss function.

The decision problem may now be contrasted with the earlier fixed-target approach to macroeconomic policy. Among the key differences between the two models, the following are particularly important.

First, the fixed-target approach assigns to both goals equal priority, while the loss function (28) permits discriminatory weighting of objectives through variations in ω. This is crucial inasmuch as it provides the most straightforward argument against one-to-one pairing of targets and instruments: as $\omega \to 1$, the optimal policy is one which assigns both control variables to x_1, for in the limit the effect of any policy which reduces $(x_2 - x_2^*)$ will not reduce the total loss, while any adverse effects of such a policy on the second target variable will enter the loss calculation with full weight. The values which ω assumes may be determined exogenously, or endogenously as when they are some function of the relative deviations of current from target values of the non-controlled variables,

$$\omega(t) = f\left[\frac{(x_{1t} - x_1^*)^2}{(x_{2t} - x_2^*)^2}\right].$$

A weighting scheme that varies over time implies that the nature of the assignment is variable as well, giving rise to time intervals during which both control variables may be used to reduce the numerator, a process

[17] While the loss function contains only noncontrolled variables, any instrument variable for which the authorities hold preferred or desired values may be included.

[18] For use of quadratic welfare functions in macroeconomic decision models, see Theil (1964) and Fox, Sengupta, and Thorbecke (1966). The former has provided an important means of dealing with uncertainty problems by developing the notion of "certainty equivalence." For an application of these techniques, see Brainard (1967).

which will serve in conflict situations simultaneously to increase the denominator.

Second, the time-discounting function $\theta(t)$ permits intertemporal discrimination among identical deviations between actual and desired values of target variables. To the decision maker a given deviation of actual from target values today may be more or less important than the same discrepancy tomorrow. Considerations of this sort are paramount when policy makers set target dates by which the criterion function is to be minimized. For if policies operate with variable lags, there will exist assignments that minimize the loss function over a given interval $t_0 t_k$ and that are thus preferred if decision makers select $\theta(t)$ such that coefficients associated with all $t > t_k$ are set at zero; but such assignments may lose their optimality for intervals defined by different $\theta(t)$.[19]

The time-discriminating function assumes special importance in the context of uncertainty. Inability to forecast accurately the behavior of the u_i or incomplete information on the B-matrix induces decision makers to place premiums on the near-future impacts of their policies. In such cases, as Theil (1964) has shown, the decision problem at time t is to set the control variables, a_i, for the first period, while hoping that the interval before the onset of the next period will produce new information on the basis of which the effectiveness of the chosen policy may be evaluated.

Third, the relationship between controlled and noncontrolled variables depends critically on the lag structure as given by the coefficient matrix B. In particular, the derivatives of Section I, dx_i/da_j, on which so many of the definitive policy prescriptions of that section depend, are there assumed to operate instantaneously. But in a model that incorporates lagged coefficients, a change in an instrument variable, with all other control variables held constant, will work its effect on a given target variable over noninstantaneous time, so that the effect as measured by the partial derivative will be the sum of the changes in the target variable over a number of elementary time units. This in turn implies that we can vary the magnitude—and in some cases the sign—of the partial derivatives by making arbitrary choices concerning the length of the relevant time interval. The short-run period of the preceding section is the result of such a choice. Choices of this sort will always be necessary, but it is the virtue of the present approach that it makes explicit this necessity and in so doing underscores the normative nature of such choices.

As we have noted, it is on the basis of the partial derivatives that evaluation of the relative effectiveness or comparative advantage of an

[19] The selection of $\theta(t)$ may be influenced by critical tests to which policy makers expect their policies to be subjected. Scheduled elections or international negotiations will bias decision makers in favor of policies that achieve maximum effectiveness prior to such events, even if the longer-term impact on target variables of such policies is weaker than that of slower-working alternatives.

instrument is based. It follows from the discussion of the previous paragraph that comparative advantage cannot normally be determined independently of the chosen time period, except in cases in which the lag structures associated with the instruments being compared are sufficiently similar. In cases not so characterized, reversals in comparative advantage are possible; that is, if control variable a_1 exerts most of its effect on target variable x_1 in $t + k$ time units, while a_2, which has a greater total effect per dose tends to generate its impact with greater lags, the ratio of the effectiveness of the two instruments will exceed unity over the interval defined by the $(t + k)$ time units and lie below unity beyond that interval.

Explicit treatment of the lag structure provides a simple means of resolving some of the problems inherent in stock-flow analysis.[20] If, in response to a change in relative world interest rates, adjustment occurs in existing asset portfolios, the time path of the balance of payments will reflect these movements of funds, even if, as in the case of a pure stock model, the capital account returns ultimately to its original position. It is this eventual disappearance of the stock effect which is stressed in a pure stock model, an emphasis which presupposes a decision concerning the time focus of the analysis. For in a stock model in which adjustment is not assumed to be instantaneous, it is not merely the fact that after the passage of some time $dB = 0$ that is of interest, but also the fact that during that time $dB/dt \neq 0$, the length of that interval depending upon adjustment speeds. It is of relevance that during the interval the loss function will reflect the ongoing capital transfers, the implication being that if the decision makers' time horizon, T, is contained within this interval, a policy that brings about stock adjustments will have served the goal of reducing the social loss associated with deviations of actual from target values.[21] That being the case, it is not strictly relevant that the stock adjustment cannot be permanent, any such argument really being a brief for the adoption of an alternative time horizon.

Finally, the nature of the lag structure can affect the stability of the system. In particular, the stability conditions of Section I do not take adequate account of lags in recognition, response, and adjustment, and rules like (23) and (24) equally ignore certain lags. If at time t the gap $(Y - Y^*)$ is what it is because the total effect of policies initiated in past periods has not as yet been registered, then decision makers acting in ignorance of this delayed reaction of the system may themselves overreact to the observed discrepancy and in consequence propel the system beyond

[20] For a cogent analysis of stock-flow phenomena, see Willett and Forte (1969).

[21] Such a policy need not, of course, be an optimal policy, that is, one that minimizes the criterion function. It may be added that the loss function will be affected by the attendant variations in official reserves if, in addition to other goals, the decision makers hold preferences with respect to reserve levels, and the loss function will further reflect the interest return flows occasioned by the reallocation of world portfolios. It is likely that the repatriation of earnings will again be determined by a lag structure.

its target. Some of the oscillations and reversals of policy actions which result from this may endanger the stability of the system.[22]

The fear of overreaction is compounded by uncertainty associated with the stochastic behavior of the u_i in equation (25), which suggests that the decision process may contain a built-in bias in favor of assigning priority to the variable with the greatest deviation of actual from desired values. This approach has the dual advantage that reduction or elimination of a relatively large gap has a greater impact on the welfare function (appropriate consideration being given to ω, θ, and B) and that moderate dosages of the two (or, in multiple instrument cases, of several) instruments applied to that target are less likely to cause overshooting. Such considerations clearly may create a presumption in favor of allocating more than one control variable to a single target,[23] and this presumption would, we suppose, be strengthened if it could be shown that, other things being the same, the lag structure contained nonlinearities such that the time path of a target variable when two control variables are assigned to it is more (or less) than the sum (or difference) of the lagged effects of the two instruments considered in isolation.[24]

In conclusion, several points may be briefly stated. First, introduction of an activity variable into the determination of capital movements creates an ambiguity in the shape of the foreign-balance function, which has the consequence of facilitating reversals of instrument assignments that are nevertheless stable. Whether such alternative assignments are more time efficient cannot be ascertained within the context of a comparative static model. But the analysis suggests that knowledge of the structure of the system enhances the power of the decision mechanism by permitting selection of the most time-efficient of alternative policy mixes.

Second, departures from one-to-one pairing may in selected cases be efficient. This presumption is supported and strengthened when the

[22] Overshooting of targets need not always be attended by disaster. Decision makers may not be entirely displeased if their attempts to eliminate a payments deficit produce a surplus, but they will surely be less content when expansionary policies designed to achieve full employment turn out to have been excessive and lead to inflationary developments. It is one of the major weaknesses of the quadratic preference function that it treats positive and negative deviations from target values symmetrically, but this failing may be moderated by setting $\omega = 1$ whenever $(x_2 - x_2^*) \geq 0$, where x_2 is the balance-of-payments surplus.

[23] This conclusion is in part a consequence of our having retained the Tinbergen-Mundell assumption that decision makers pursue unique values rather than ranges of values of the noncontrolled variables.

[24] For example, the private sector's expectations may exhibit nonlinear response patterns when fiscal expansion-cum-monetary contraction is replaced with expansion in both. This underscores the importance for effective use of the criterion function of prior estimates on the structure of the economy. The necessary information input is substantially more elaborate than the simple estimates of the signs of the partial derivatives in the Tinbergen-Mundell framework. As the discussion of the present section implies, without prior information on such things as the lag structure and the configuration of official preferences, the formal analysis would decline rapidly into taxonomy.

Tinbergen-Mundell fixed-target–fixed-time framework is replaced by a less restrictive criterion function. In the process of minimizing a quadratic loss function, which permits preferential ordering of goals and endogenous determination of the time horizon, decisions emerge which assign both control variables in a two-by-two model to one of the two state variables for an interval equal to or smaller than the time horizon.

Where the structure of the system is unknown, the correct approach in the Tinbergen-Mundell model is to manipulate each instrument in accordance with excess demand in the market to which it has been assigned, while minimization of the criterion function may require that both instruments be assigned to the greatest (weighted) deviation of actual from target values. The latter approach has the further advantages of generating a performance integral by which the effectiveness of policy may be evaluated, and of providing decision criteria even in cases in which the numbers of independent instruments and targets are not identical.

Third, the greater flexibility of the criterion function is achieved not without cost, for it virtually precludes the derivation of simple and unambiguous decision rules. One of the principal advantages of the Tinbergen-Mundell decision rules is their simplicity, particularly in the context of limited information on the structure of the economy. In gaining such simplicity, however, the analysis makes important concessions to rigidity. In the real world, policy makers may be observed to behave in contradiction of the decision rules stipulated in internal-external balance models, as, for example, when they assign both monetary and fiscal instruments to removal of internal imbalance, while ignoring external imbalance. This may be due to their not having discovered the Tinbergen-Mundell principle of efficient allocation of controls, or to the existence of temporal (θ) and atemporal (ω) official preferences and of lag structures (B) which are inconsistent with the essential neutrality implicit in the Tinbergen-Mundell framework. Under such circumstances, generation of decision rules by means of the more flexible criterion function would appear preferable, although the derivation of such rules requires a much greater input of empirical estimates on the structure of the economy.

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