CHAPTER 2
THE MACROECONOMIC IMPLICATIONS OF DEVALUATION AND IMPORT RESTRICTION

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The main purpose of this paper is to set out a framework in terms of which a rigorous discussion of alternative trade strategies can proceed. It is not concerned with the legal, or what may broadly be called administrative, implications of the alternatives, but will demonstrate that on certain assumptions about macroeconomic relationships the gain to employment, real wages and prices brought about by import restriction is extremely large compared with a policy of devaluation, particularly in the first few years after the policy is introduced.

Introduction

Through the last few years the CEPG has suggested that large-scale and long-term restriction of imports may be necessary if the UK is to recover full employment; also that protection may well moderate the rate of inflation compared with a strategy of exchange rate depreciation. These suggestions have so far met with almost universal opposition, not least from professional economists.

The most influential modern works on international trade theory [for example Johnson (1971) and Corden (1974)] explicitly make and maintain the assumption that the quantity of output (and therefore presumably employment) is given. The core of their argument then concerns the response to alternative policies of the terms of trade, which alone can generate any putative benefits from protection. But, however elaborate the theoretical superstructure which is erected on this basis, such work must of its essence beg the major policy question with which we are concerned; for this central question is not merely through what agency and how quickly full employment can be achieved without protection, but whether it can be achieved at all.

This paper aims to give a simplified, but mathematically rigorous, exposition of the macroeconomic implications of alternative trade strategies. The problems addressed here are in many respects the same as those in the study 'Import controls *vs.* devaluation' by Messrs. Corden, Little and Scott (CLS) which contested the views put forward by the CEPG in its first *Economic Policy Review* in February 1975. The intention here is not merely to answer the main points made by CLS, but as a matter of methodology to fill a gap between verbal argument [such as used by CLS and by Corden (1977)[1]] and the crude presentation of numbers which emerge from computer simulations. When assumptions are not defined by precise equations, and mathematical theorems are absent, verbal argument can degenerate into something reminiscent of thirteenth century scholasticism; conversely, in the absence of analytic understanding, the behaviour of a large computer model can be mistrusted, as depending on special choices of input data which are not necessarily acceptable and as being of course conditional on the model itself.

It was as a compromise between these two extremes that Cripps and Godley (1976, hereafter referred to as CG) recently presented a formal analysis of a relatively simple and highly aggregated model, which incorporates the essential assumptions of the full CEPG model. They were thus able to give relatively simple, and mathematically exact, formulae for the way quantities such as imports, exports, real national output and income behave under the well defined initial economic assumptions of the model. The CG study lies squarely in the tradition of classical applied mathematics: the aggregated model is a pedagogic device, whereby the dynamical properties of the underlying model can be discussed with a rigour that is difficult in verbal exposition, and with an understanding that is difficult in large computer studies.

The present paper is complementary to CG but different in the crucial respect that, whereas CG explicitly omitted short-term dynamics and looked only at the long-term behaviour of their model, the present paper is focussed on short-term dynamical responses, and particularly on the short-term dynamical differences in real national output, real national income, and real disposable wages under various policy options.

It cannot be too strongly emphasised that the purpose of this paper is to describe precisely how an economy would work under well defined assumptions. To the extent that the assumptions are artificial so are the theorems and numerical results. It will only be in the final section that some tentative speculations will be made as to the operational significance of this work; and even in this section artificial assumptions about what may broadly be termed administrative feasibility have been retained.

Aims and policy instruments

We assume that the object of policy is simultaneously to achieve target values for employment and for the

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[1]See Chapter 2 of *On how to cope with Britain's trade position*, Trade Policy Research Centre, January 1977. Corden's contribution has no penetration because it is unrigorous and dogmatic; those by Hugh Corbet and Brian Hindley contain a large number of errors, particularly on the properties of the CEPG model, that are best answered by referring readers to the technical manual by Fetherston (April 1976) of which there will be a revised version in the Spring of 1977.

current balance of payments. The model employed combines the 'elasticity' approach to the balance of payments (in which exports and imports are determined by relative prices) with a simple 'portfolio balance' approach, in which the stock of financial assets owned by the private sector is kept in some relationship to its disposable income. The policy instruments available for the task are assumed to be tariffs on imports (at a rate t_m), subsidies on exports (at a rate s_x), value-added-taxes on personal consumption (at a rate t_{vat}), and import quotas (amounting to an *ex ante* import volume reduction $\overline{m}_q$). We assume in our model that foreign countries do not retaliate against our exports if tariffs or quotas are imposed, nor do they indulge in competitive devaluation.

Although much of the formal discussion is in terms of a combination of the above policy instruments, the basic interest lies in the comparison between pure strategies of devaluation, versus two kinds of import restrictions, namely *tariffs* only or *quotas* only, these three strategies being special cases of the general combination of t_m, s_x and $\overline{m}_q$. As is well known, to a close approximation, a devaluation of $x\%$ is logically equivalent to setting $t_m = s_x = x$ where t_m is a tariff on all imports of goods and services. The main differences between a tax/subsidy scheme and devaluation arise because in the latter case there is a revaluation of foreign assets and net property income from abroad; we doubt whether such revaluation would significantly alter our results. A tariff-only policy will generally apply to selected categories of imports only.

The assumptions of our model make it unnecessary to give separate consideration to monetary policy or to the capital account of the balance of payments. This is (1) because the stock of financial assets which the private sector holds in a given relation to income is assumed to include net foreign assets, and (2) because the target for external finance is assumed to be *current* balance of payments. Implicitly the latter involves us in a supposition that private capital outflows on the balance of payments are either prevented or can be financed by official borrowing or reserves.[1]

The accounting framework

The device we have used to display the differences between trade strategies is to compare the consequences of each with some alternative evolution of the economy in which none of them is adopted. This technique of analysing changes compared with 'baseline' values, using linearised approximations (defined more fully below) to treat the ensuing equations, is widely used for dealing with dynamical systems in the physical and biological sciences, and gives relatively simple results which are accurate to within well defined limits.

The 'baseline economy' may be written in terms of the national income identity *at current prices*

$$\mathbf{Y}^*_t = \mathbf{XP}^*_t + \mathbf{G}^*_t + \mathbf{X}^*_t - \mathbf{M}^*_t - \mathbf{FCA}^*_t \qquad (1)$$

where $\mathbf{Y}^*_t$ = national income and output
$\mathbf{XP}^*_t$ = private expenditure at market prices (consumption and investment)
$\mathbf{G}^*_t$ = government expenditure on goods and services
$\mathbf{X}^*_t$, $\mathbf{M}^*_t$ = exports, imports of goods and services
$\mathbf{FCA}^*_t$ = net indirect taxes.

In order to focus attention on the problem of unemployment which is now assuming such importance in the UK, it will be assumed that in the baseline economy the current balance of payments ($\mathbf{X}^* - \mathbf{M}^*$) is always zero while unemployment is high and continuously rising. Naturally for such an evolution to occur it has to be assumed that the conditions for simultaneous internal and external balance are not fulfilled, and that the zero current balance is only achieved by the government using fiscal and monetary policy to keep the growth of output progressively lower than that of productive potential.

An unrealistic assumption is now made (to which we shall return later) that average money earnings are the same under each alternative as in the baseline economy.

The various trade strategies may now be explored by analysing the differences made by each of them to the baseline economy, these differences being represented throughout by unstarred symbols. As changes in public expenditure are excluded by assumption from the policy instruments, differences (compared with the baseline economy) may be written as

$$Y_t = XP_t + X_t - M_t - FCA_t \qquad (2)$$

where all variables are measured at current prices and

$$\overline{Y}_t = \overline{XP}_t + \overline{X}_t - \overline{M}_t - \overline{FCA}_t \qquad (3)$$

where the bar denotes that the variables are all measured at the prices of the baseline economy. Thus, notwithstanding that equation (1) is entirely in current prices, $\overline{Y}/\mathbf{Y}^*$, $\overline{X}/\mathbf{X}^*$, $\overline{M}/\mathbf{M}^*$ etc. measure proportionate additions to output and to the components of demand at constant prices.

For exports, imports and private expenditure the relationship between equations (2) and (3) follows logically from accounting identities. Thus

$$X_t = \overline{X}_t . \Pi X_t + \mathbf{X}^*_t(\Pi X_t - 1) \qquad (4)$$

$$M_t = \overline{M}_t . \Pi M_t + \mathbf{M}^*_t(\Pi M_t - 1) \qquad (5)$$

$$XP_t = \overline{XP}_t . \Pi XP_t + \mathbf{XP}^*_t(\Pi XP_t - 1) \qquad (6)$$

where ΠX, ΠM and ΠXP represent the ratios of the prices of exports, imports and private expenditure to their levels in the baseline economy. The value of the change in net indirect taxes is

$$FCA_t = \overline{FCA}_t + TM_t + TV_t - SX_t \qquad (7)$$

where TM, TV and SX are money yields from discretionary changes in tax and subsidy rates (t_m, t_{vat} and s_x) while $\overline{FCA}$ is the money yield from existing indirect tax rates resulting from $\overline{XP}_t$.

The trade responses

To a good approximation, the response of import prices to a tariff on imports will be immediate. The tariff may, however, not be fully passed on, so that the import price subsequent to the introduction of tariff t_m takes the form

$$\Pi M = 1 - vt_m \qquad 0 < v < 1 \qquad (8)$$

[1]These are probably not strong assumptions in the present context, since we are undertaking comparisons between alternative situations in each of which the private sector's stock of financial assets is assumed to be throughout in the same ratio to its disposable income, while in the long term the current balance of payments and also the public sector's borrowing requirement are tending to be the same as well.

The cum-tax import price will be:

$$\Pi M \text{ (cum tax)} = (1 - vt_m)(1 + t_m)$$

Or, to a good approximation:

$$\Pi M \text{ (cum tax)} \simeq 1 + (1 - v)t_m \qquad (9)$$

Similarly, the effect of subsidies on export prices is to produce in the absence of tariffs on imports:

$$\Pi X = 1 - us_x. \qquad 0 < u < 1 \qquad (10)$$

If there is a tariff on all imports imposed simultaneously with the subsidy on exports, the export price difference is assumed to take the form

$$\Pi X = 1 - us_x + \omega'(1 - v)t_m \qquad (11)$$

where ω' is the proportion of costs (excluding profits) taken by imports.[1] In the case of a tariff-only policy it will be assumed that a 'tariff drawback' will simultaneously be introduced, i.e., exporters can reclaim the tariff element in their own costs so that $\omega' = 0$ in such a case. The fact that tariffs entering export costs are assumed to be rebated under a tariff strategy requires that to reduce ΠM (i.e. the average price of all imports) by the amount shown in equation (8) the rate of tariff must exceed t_m. We shall assume that the import content of private expenditure is roughly equal to that of exports and that the import content of government expenditure is nil. Accordingly for the tariff strategy the rate at which the tariff has to be calculated is given by

$$t_m' = t_m\left(\frac{\mathbf{XP^*} + \mathbf{X^*}}{\mathbf{XP^*}}\right) \qquad (12)$$

In future, wherever the term t_m is used in an expression to describe a tariff strategy, this must be understood as the average rate of tax on all imports implied by the rate t_m applied selectively. As the import prices of basic materials are for the most part determined in world markets and price 'shading' most typically occurs in the case of manufactured goods, there is reason to suppose that v will take on a greater value the more tariffs are applied selectively.

Changes in the terms of trade, according to equations (9) and (11) are:

$$TT = \frac{\Pi X}{\Pi M} = \frac{1 - us_x + \omega'(1 - v)t_m}{1 - vt_m} \qquad (13)$$

$$\simeq 1 - us_x + [v + \omega'(1 - v)]t_m$$

For a country like the UK, whose exports are predominantly manufactures and the majority of whose imports are food and materials, it may uncontroversially be assumed that $u > v + \omega'(1 - v)$. Equation (13) then says that devaluation ($t_m = s_x$) worsens the terms of trade compared with the baseline economy, and tariffs ($s_x = \omega' = 0$, $t_m \neq 0$) improve them.

It also says that quotas ($t_m = s_x = 0$) leave the terms of trade unchanged so long as it is assumed that foreign suppliers do not raise their prices at all in response to such restrictions.

The relationship between changes in the prices and volumes of exports and imports are represented as log-log equations and are incorporated as such in CG. We are content here with the linear approximation,

$$\overline{X}_t = -\epsilon_t \mathbf{X}_t^* (\Pi X - 1) \qquad (14)$$

where ϵ_t represents the price elasticity of foreign demand for exports. The subscript t has been retained, because although price changes occur almost instantaneously, the consequent export volume changes involve time lags. We write ϵ for the long-term (asymptotic) value of ϵ_t. Such asymptotic values are used throughout CG, which deliberately ignores short-term effects. Note that equations (10) and (14) can be combined to give $\overline{X}$ directly as a function of s_x and t_m

$$\overline{X}_t = \epsilon_t[us_x - \omega'(1 - v)t_m]\mathbf{X}_t^* \qquad (15)$$

The corresponding empirical relation for the change in *ex ante* import volume, $\overline{m}_t$ in response to changes in prices is

$$\overline{m}_t = -\eta_t \mathbf{M}_t^*(\Pi M[\text{cum tax}] - 1). \qquad (16)$$

That is, using equation (9) to introduce tariffs explicitly,

$$\overline{m}_t = -\eta_t (1 - v)t_m \mathbf{M}_t^* \qquad (17)$$

where η is the price elasticity of demand for imports. Just as the value of v is likely to be higher if tariffs are applied selectively to competitive rather than complementary imports, so also is the value of η.

Changes in real national output

Our device for comparison of the three strategies is first to assume that under each of them the current balance of payments is held (as in our preferred baseline economy) to zero throughout, by whatever manipulation of the internal tax rate (t_{vat}) is necessary. Given this assumption it is easy to solve for $\overline{Y}$ and the detailed steps are given in Appendix C. To first order in s_x and t_m (i.e. neglecting terms which involve the product of two or more such quantities), the result is

$$\mu \overline{Y}_t = [us_x - \omega'(1 - v)t_m][\epsilon_t - 1]\mathbf{X}^* + t_m\mathbf{M}^*[v + \eta_t(1 - v)] \qquad (18)$$

Here μ is the marginal propensity to import (relative to GDP volume).[2]

This overall change in $\overline{Y}$ is a mixture of price effects, which are expressed immediately, and volume effects, which are lagged. In the long term, the system settles to its asymptotic value (with $\epsilon_t = \epsilon$ and $\eta_t = \eta$), of which the long-term dynamics are discussed in CG.

The following theorem brings devaluation ($s_x = t_m = t_{dev}$) and import tariffs, ($s_x = 0$ and $t_m' = t_{tar}$) into equivalence so far as the long-term value for $\overline{Y}$ is concerned, so long as it is assumed that $\mathbf{X^*} = \mathbf{M^*}$ and forgetting the complication that v and η will tend to be higher (not necessarily by an equal proportionate amount) the more tariffs are directed toward competitive imports.

$$\frac{t_{tar}}{t_{dev}} = \left(1 + \frac{[u - \omega'(1 - v)][\epsilon - 1]}{v + \eta(1 - v)}\right)\theta \qquad (19)$$

where $\theta = \dfrac{\mathbf{XP^*} + \mathbf{X^*}}{\mathbf{XP^*}}$

[1] Should devaluation be used, instead of t_m and s_x ΠM will equal the change in the 'dollar' price of imports, while ΠM (cum tax) will be the change in the sterling price of imports. ΠX represents the fall in the *dollar* price under devaluation; the sterling price of exports rises under this assumption

$$\Pi X = 1 + (1 - u)s_x + \omega'(1 - v)t_m$$

[2] Strictly speaking we are postulating in μ a fixed relationship between an addition to output and an addition to imports both measured at the current prices of the baseline economy in year t. This would produce nonsense answers if the baseline economy contained significant changes in the terms of trade, so we are assuming that it does not do so.

In the case of quotas it is assumed that the scheme is operated by cutting some category of imports and holding them at that level subsequently, thereby reducing the marginal propensity to import compared with μ. If we can assume that quotas can be made instantly effective, the solution for $\bar{Y}$ is simply

$$\mu' \bar{Y} = \bar{m}_q. \quad (20)$$

where the prime indicates a different (lower) marginal propensity.

The following two expressions bring quotas into equivalence, for a given long term value for $\bar{Y}$, with devaluation and tariffs.

$$\bar{m}_q = t_{dev}\{[u-\omega'(1-v)][\epsilon-1]\mathbf{X}^* + [v+(1-v)\eta]\mathbf{M}^*\}\,[\mu'/\mu] \quad (21)$$

$$\theta \bar{m}_q = t_{tar}\mathbf{M}^*[v+(1-v)\eta][\mu'/\mu] \quad (22)$$

We now consider the short term dynamics, en route to a common asymptotic value of $\bar{Y}$.

For import quotas there is no dynamical behaviour for $\bar{Y}$ under our assumption that the balance of payments does not change at any stage. We may therefore simply adopt equation (20) above and write a time subscript under $\bar{Y}$.

For tariffs, equation (18) becomes

$$\mu \bar{Y}_t\,(\text{tariff}) = t_m[v+\eta_t(1-v)]\mathbf{M}^* \quad (23)$$

Note that, even if the volume response is slow, $\bar{Y}_t$ *must always be positive* for all reasonable values of the parameters.

For devaluation, equation (18) becomes

$$\mu \bar{Y}_t(\text{devaluation}) = t_m\{[u-\omega'(1-v)][\epsilon_t-1]\mathbf{X}^* + [v+\eta_t(1-v)]\mathbf{M}^*\} \quad (24)$$

In the export-driven term, the price response provides an immediate negative effect and the volume response provides a lagged positive effect. Although the volume response will make $\bar{Y}$ positive in the long run (so long as the Marshall Lerner conditions are satisfied) there can easily be short-term net negative effects. Indeed as we shall see, these short-term negative effects can be sufficiently substantial to overcome the import-driven term, leading to a net initial *decrease* in $\bar{Y}$.

Put in a more conventional way, if the terms of trade move adversely quickly and the volume responses are slow, the condition we have imposed that the current balance is always zero may require that t_{vat} be initially raised on a scale which will cause $\bar{Y}$ to be negative.

Changes in the real national income

Changes compared with the baseline economy in the real national *income*, $\overline{YR}$, are determined by changes in the real national output, $\bar{Y}$, and in the terms of trade, TT. To a linearised approximation, we have (so long as $\mathbf{X}^* = \mathbf{M}^*$)

$$\overline{YR}_t = \bar{Y}_t + \mathbf{M}^*(TT-1) \quad (25)$$

which may be approximated by

$$\overline{YR}_t = \bar{Y}_t + \{[v+\omega'(1-v)]t_m - us_x\}\mathbf{M}^* \quad (26)$$

with $\bar{Y}_t$ given by equation (18).

The volume of real national income $\overline{YR}_t$ then differs from $\bar{Y}_t$ by an unlagged term which is positive for tariffs, zero for quotas, and negative for devaluation:

$$\overline{YR}_t(\text{tariff}) = \bar{Y}_t\,(\text{tariff}) + vt_m\,\mathbf{M}^*, \quad (27)$$

$$\overline{YR}_t(\text{quotas}) = \bar{Y}_t\,(\text{quotas}), \quad (28)$$

$$\overline{YR}_t\,(\text{devaluation}) = \bar{Y}_t\,(\text{devaluation}) - [u-\omega'(1-v)-v]t_m\mathbf{M}^*. \quad (29)$$

Thus for a given long-term value of $\bar{Y}$, real national income will be least with devaluation and greatest with tariffs, while in view of the short-term dynamical properties of $\bar{Y}$ that have just been discussed, these trends in $\overline{YR}$ under the three strategies will be (proportionately) more pronounced in the short term than in the long.

Changes in real take-home pay

There are three reasons why under each strategy the proportionate change in real disposable wages will be different from that in the real national income. First, since government expenditure on goods and services is assumed to be given, the whole of $\overline{YR}$ accrues to private expenditure. Second, the three strategies imply differences in the distribution of real private disposable income between pay and other income. Third, as the initial response of the private sector to changes in disposable income is, in part, to accumulate financial assets, the level of internal taxes has to be different if all the output generated by the different strategies is to be bought.

The addition to real take-home pay has three components; that which is received by people entering employment who would otherwise be unemployed, that which derives from higher overtime pay for those already in employment and that which results from alterations to the level of consumer prices. It is this last category which is of particular interest because, apart from the importance of prices *per se*, what is being measured is the alteration in the post-tax real purchasing power of a standard hour's work. Recall that we have so far assumed money wages given, so the differences in price behaviour are crucially important with regard to the inflationary tension they generate.

It will emerge that in each case the benefit (or loss) to average real pay is larger than that to real national income, this benefit (or loss) always being *additional* to the effect on employment.

Our assumption about consumer prices is that these are determined entirely by (normal) unit costs and indirect tax rates. Lags can be ignored, because indirect taxes are generally passed on immediately, while the cost of materials is passed on with a mean lag of well under half a year.

More specifically (normal unit labour costs being given), it is assumed for a tariff strategy that

$$\Pi C_t = [(1-vt_m')(1+t_m')\omega + (1-\omega)](1+t_{vat})_t \simeq 1+\omega(1-v)t_m' + t_{vat,t} \quad (30)$$

where ΠC represents consumer prices as a ratio of those in the baseline economy. For a devaluation strategy the expression is identical except that t_m should be substituted for t_m'. For quotas $t_m = t_m' = 0$. The formula for consumer prices implies that neither foreign exporters nor domestic importers raise their prices under a quota strategy.

To obtain consumer prices we now have to find an expression for t_{vat}, the change in the indirect tax rate which, it has been assumed, is continuously adjusted so as to keep $X = M$, and this is by far the most complicated part of the exercise. The main economic assumption which has to be made concerns the relationship between disposable income and the stock of financial assets held by the private sector; this relationship may alternatively be expressed in terms of the relationship between the additional disposable private income which is created and the expenditure which this, in turn, generates.

Our assumption about the relationship between disposable income and the stock of financial assets takes the form

$$SFA = (1-a)(1-\tau_d)Y \tag{31}$$

where SFA is the stock of financial assets (compared with that in the baseline economy) and τ_d is the marginal direct tax rate on total private factor income.

Equation (31) may alternatively be written (since $\triangle SFA \equiv (1-\tau_d)Y - XP$) as the aggregate expenditure function

$$XP_t = a(1-\tau_d)Y_t + (1-a)(1-\tau_d)Y_{t-1} \tag{32}$$

The tedious manoeuvres which, using this equation, link $\overline{Y}_t$ with $t_{vat,t}$ have been banished to Appendix C. The expression for t_{vat} corresponding to any long-term value for $\overline{Y}$ linearises to

$$t_{vat,\infty} = -\frac{[1-(1-\tau_i)(1-\tau_d)]}{(1-\tau_i)\ \gamma \mathbf{XP^*}}\ \overline{Y}_\infty + a_1 s_x - a_2 t_m \tag{32}$$

where τ_i is the baseline marginal rate of indirect tax on private expenditure, γ is the proportion of **XP*** taken by personal consumption, and a_1 and a_2 are constants which are precisely defined in Appendix C. Thus equation (32) says so long as the Marshall Lerner conditions hold in the long run (i.e. $\overline{Y}_\infty$ is positive when $X = M$) and if a_1 and a_2 are roughly equal, t_{vat} will ultimately be reduced under all three strategies. It will be reduced most under the tariff strategy; and more or less with quotas compared with devaluation depending on the relative size of a_1 and a_2.

Note that net acquisition of financial assets by the government, overseas and private sectors must sum to nil. Therefore it t_{vat} is set so as to achieve a zero current balance of payments, while in equilibrium $Y(1-\tau_d) - XP$ is roughly equal to zero, it follows that the *ex post* public sector financial deficit is (in the long run) unchanged under every strategy. In other words the changed yield from baseline tax rates must, under these assumptions, equal the net yield of the discretionary changes in tax and subsidy rates. Formally

$$\tau_d Y + \tau_i \overline{XP} = -t_m(\mathbf{M^*} + M) + s_x(\mathbf{X^*} + X) - \gamma t_{vat}(\mathbf{XP^*} + XP) \tag{33}$$

Empirical relations and numerical results

In this section we shall infer some numerical results which are appropriate for the British economy under certain well specified assumptions.

The empirical relations which are crucially important for producing illustrative numbers are the price and volume response of exports and imports to s_x and t_m, the way consumer prices are determined and the relationship between private disposable income and expenditure.

It is assumed that $v=0{\cdot}1$, whereupon equation (8) says that a 10% tariff on all imports of goods and services leads to a 1% lowering of ex-tax import prices. (A 10% devaluation under the counterpart assumption would lead to a 9% rise in sterling import prices.)[1]

It has been assumed that $u=0{\cdot}6$ and that $\omega'=0{\cdot}33$, so equation (11) says that with $t_m = s_x = 10\%$, export prices (in both sterling and 'dollar' terms) fall by 3%. (A 10% *devaluation* would (under a counterpart assumption) lead to a 3% fall in 'dollar' prices and therefore a 7% *rise* in sterling export prices.)[2]

We take 2·5 and 0·5 as acceptable values for ϵ and η in the UK, the aggregate long-run price elasticities of demand for respectively exports and imports. The low figure for η is consistent with an elasticity of about 2 for imports of finished manufactures.

These numbers are sufficient to evaluate equation (19), which brings tariffs and devaluation into equivalence with one another. The expression implies that if confined to goods not entering into export costs the rate of tariff (t_m') would have to be just over twice as large as devaluation to produce the same long-term value for $\overline{Y}$ (ignoring once again that if tariffs are selectively applied v and η would both be higher). If the tariffs were confined to finished manufactures they would have to be at a higher rate still, though probably only a little, for while the value of v might be slightly larger, the price elasticity of demand η would be very much higher, probably as high as 2.

So far as the temporal behaviour of the empirical coefficients ϵ_t and η_t are concerned, we have assumed that it would take three years for each to obtain its asymptotic value. Thus, supposing the measures are imposed at the beginning of year 1, it is assumed the volume responses would be complete after three years, giving 10%, 25%, 60% and 100% of the asymptotic values in the annual totals for years 1, 2, 3 and 4.

These empirical relationships enable us to evaluate for each strategy the magnitude of the gestures required to achieve some given increase in output and employment, together with its time profile, so long as we continue to assume that fiscal policy is in each case continuously adjusted so as to keep the balance of payments unchanged.

Let us suppose the baseline economy is roughly the same as the British economy in 1975, i.e., the crucial ratios are those implied by the following numbers:

$\mathbf{X^*} = \mathbf{M^*} = £27b.$
$\mathbf{PX^*} = £75b.$
$\mathbf{G^*} = £32b.$
$\mathbf{FCA^*} = £10b.$
$\mathbf{Y^*} = £97b.$

As personal consumption was £63b., $\gamma = 0{\cdot}84$.

We have already assigned values to ϵ, η, u and v (namely 2·5, 0·5, 0·6 and 0·1). We further assume that $\mu = 0{\cdot}35$ and $\mu' = 0{\cdot}25$, the rather large difference between the two arising because it is on finished manufactures (for which the marginal propensity for import is very large) that the main restrictions would fall. We assume finally that $\tau_i = 0{\cdot}1$, $\tau_d = 0{\cdot}3$.

Now should the objective be to raise real output by 10%, thereby ultimately raising employment by about 5% and reducing unemployment by about 3% (or 750,000), equations (18) and (20) imply that the necessary step devaluation would be 12½%, the average rate of tariff on imports of goods and services entering domestic expenditure would have to be 31%, while

[1]We are writing as though the complications of the 'green' currencies do not exist.

[2]We write throughout using linear approximations. In reality simulation of a 10% devaluation would require $s_x = 0{\cdot}10$, $t_m = 0{\cdot}11 = (\frac{100}{90} - 1)$. The 3% fall in dollar prices under devaluation would therefore become an 8% rise in sterling price (i.e. $\frac{97}{90} - 1$). Similarly the non-linearised rise in import prices would be 10% (i.e. $\frac{99}{90} - 1$).

the reduction in imports by quota restriction (compared with what otherwise would have happened) would initially have to be worth 9% of **M*** i.e., about £2½ billion in the UK economy, rising ultimately to about £3⅓ billion (both at 1976 prices).

In calculating numerical values for the counterpart changes in consumer prices, we make the assumption that in equation (31) $a=0{\cdot}6$.

Now, using equations (20) (23) (24) (27) (28) (29) (30) and (32), we can write down values for all the crucial variables, assuming that the long-term addition to GDP is 10% and that the current balance is not allowed to change.

These results must not without heavy qualification be taken as realistic estimates of what could happen under the alternative trade strategies, because of the uncertainty of some of the assumptions employed; it is important to recall nevertheless that any benefit to real take-home pay caused by lower consumer prices is *additional* to any benefit from higher employment and overtime.

As the assumption that the balance of payments is not allowed to change at any stage is an extreme one, involving enormous difficulties in its execution, we have reworked the answers, using the same assumptions about trade policy instruments, but setting t_{vat} immediately at its long-term value. Thus the consumer price change is fixed for each option and the dynamics are thrown back into output and the balance of payments; the detailed mathematical relationships are given fully in Appendix C.

Assessment

We first note that there are legal, institutional, diplomatic and administrative obstacles to our freedom to use trade policy instruments, *including devaluation*, in the way so far assumed; and that foreign countries may render any or all of these policies ineffective by retaliation. Beyond observing that as a matter of history certain countries, e.g. Germany and Japan, have maintained protection for long periods (and thrived under it) these points will not be further discussed here, although it is recognised that they may singly or together make it impossible to implement any of the strategies under review.

What we briefly discuss in this final section, having made a heroic assumption about what may broadly be called administrative feasibility, is the validity of our results as predictions conditional on such feasibility.

Numbers for crucial variables assuming $\overline{Y}/Y^*=10\%$ in long term and $X=M$ throughout.
Per cent changes compared with the 'baseline economy'

Year	1	2	3	4	5
A. Devaluation (at 12½%)					
$\overline{Y}$	−0·8	+1·0	+5·2	+10·0	+10·0
$\overline{YR}$	−1·5	+0·3	+4·5	+9·3	+9·3
t_{vat}	−1·0	−2·3	−5·9	−9·2	−7·3
Consumer prices	+2·8	+1·5	−2·1	−5·4	−3·4
B. Tariffs (on goods and services entering domestic expenditure) at 30·9%					
$\overline{Y}$	+2·6	+3·9	+6·7	+10·0	+10·0
$\overline{YR}$	+3·3	+4·5	+7·4	+10·6	+10·6
t_{vat}	−12·1	−12·5	−14·9	−17·2	−15·8
Consumer prices	−2·8	−3·2	−5·6	−7·9	−6·5
C. Quotas (cutting by 9% of M*)					
$\overline{Y}=\overline{YR}$	+10·0	+10·0	+10·0	+10·0	+10·0
t_{vat}	−10·5	−6·3	−6·3	−6·3	−6·3
Consumer prices	−10·5	−6·3	−6·3	−6·3	−6·3

Numerical results assuming $\overline{Y}/Y^*=10\%$ in the long term but with t_{vat} fixed initially at its long-term value

Year	1	2	3	4	5	6	7
A. 12½% devaluation, 7·3% reduction in t_{vat}							
Change in consumer prices is −3.4% throughout							
$\overline{Y}$(%)	+3·0	+4·9	+7·0	+9·2	+9·8	+9·9	+10·0
$\overline{YR}$(%)	+2·3	+4·2	+6·3	+8·5	+9·1	+9·2	+9·3
$X-M$(£ b.)[1]	−1·2	−1·3	−0·6	+0·3	+0·1	0	0
B. 30·9% tariff, 15·8% cut in t_{vat}							
Change in consumer prices is −6·3% throughout							
$\overline{Y}$(%)	+4·9	+6·5	+7·9	+9·5	+9·9	+10·0	+10·0
$\overline{YR}$(%)	+5·5	+7·1	+8·5	+10·1	+10·5	+10·6	+10·6
$X-M$(£ b.)[1]	−0·8	−0·9	−0·4	+0·2	0	0	0
C. Quotas at 9% of M*, a cut of 6·3% in t_{vat}							
Change in consumer prices is −6·3% throughout							
$\overline{Y}=\overline{YR}$(%)	+7·1	+9·2	+9·8	+9·9	+10·0	+10·0	+10·0
$X-M$ (£ b.)[1]	+0·7	+0·2	+0·1	0·1	0	0	0

[1]Assuming **X***=**M***= £27 billion.

So far as the price and volume responses of exports and imports are concerned, we are pretty confident that we have attributed values to these which are about right and which most people will accept. It is worth noting that none of the 'repercussions' mentioned by Corden (1977) are important given our assumptions. As we have assumed a baseline economy which, like the UK economy, has high and growing unemployment, it is unnecessary to take account of capacity constraints. At the same time we have assumed a very high import content for all expenditure diverted to domestic purchases. Accordingly our answers for real national output and income *if M could really be held equal to X* would appear to be correspondingly well founded.

Our view about the determination of consumer prices is more controversial. Many would say that under the 'law of one price' the response of domestic producers of all goods which are competitive with imports will be to increase prices by fully as much as import prices; indeed the 'Scandinavian' theory of inflation and its transmission is based specifically on this assumption. Here, however, we are disposed to stick to what may appear an extreme position, since the law of one price appears to have little empirical foundation. Indeed the very elaborate study by Coutts, Godley and Nordhaus (1977), which examines the relative movement of domestic and competitive import prices for seven UK industries over a period of several years, finds no effect of the latter on the former whatever. And, generally speaking, pure 'mark up' models of consumer price determination, such as those in Godley and Rowe (1964) and Coutts (1975), have given good results.

A more controversial major empirical assumption is that all private disposable income gets spent within two years, for which the econometric evidence is set out in Fetherston (1976). But those who disagree with this assumption (given that they accept the hitherto conventional view that income and output are determined by exogenous variables operating through a multiplier process) will, we believe, generally suppose the 'leaks' to be *larger* than we have assumed—i.e. that the spending relative to income will tend to be less and take longer to materialise. But this would necessarily strengthen our answers, in the sense that it would require falls larger than we have entered for t_{vat} (and therefore lower consumer prices) in the long term and even *more* violent changes in the short run. A qualification to this relationship should be added—that any very violent change in total final sales would result in abnormal destocking and supply constraints, so for a time total expenditure would be lower in relation to disposable income than we have assumed; in other words the short-term output responses to the quota strategy look impossibly large. There is no reason, however, why the tax cuts could not be phased in much more gradually under a quota strategy, allowing the balance of payments to improve initially, with the result that the short-term benefits to output and real income would be smaller.

Another very questionable major empirical assumption so far made is that average money wages would be unaffected by the adoption of any of the strategies. There is a clear possibility, since it is only plausible to assume that fiscal policy must be operated so as to prevent a major deterioration in the current balance at any stage, that the response of money wages to the initial loss of real wages under the devaluation strategy will make the policy largely, if not wholly, ineffective; the implication of this could in one extreme case be that devaluation ultimately adds a fully equivalent amount to the rate of price inflation and nothing at all to real output or income. No parallel qualification needs to be made for the protectionist strategies, except on the assumption which is, to us, extremely implausible, that the initially higher pressure of demand for labour would operate, under some Phillips curve mechanism, to offset the benefits to the price level achieved directly.

If we ignore (without ever forgetting) that devaluation may be ineffective, by resuming the assumption that money wages are given, there remains a very difficult problem of assessing our results, which arises from the real difficulty of how fiscal policy should be conducted. For instance, it is not generally likely that a devaluation strategy could be accompanied by a simultaneous huge tax cut, leading to the balance of payments being about £3 billion worse in total than it would otherwise be in the first three years, any more than it is conceivable that quotas could be accompanied by an even more huge tax cut with output rising 10% in the first year.

There is no simple way of setting out the alternatives comprehensively, particularly as the strategies could be combined in changing proportions, e.g. protection might gradually be phased out and devaluation substituted for it.

As there are major difficulties about the conduct of fiscal policy under each strategy, it seems that the crucial results are best presented as comparisons of the two protectionist strategies with devaluation on the two assumptions about fiscal policy already used and which may be regarded as extremes; these assumptions are, on the one hand that the balance of payments is held to zero throughout, on the other that t_{vat} goes at once to its long-term value. The numbers below are simple inferences from the two previous tables.

What these figures show is that, apart from the substantial permanent increase in real pay, there is an enormous advantage during a longish transitional period (i.e. one lasting for two or three years) to output, employment, prices and real incomes in adopting a protectionist strategy and that these vastly exceed the gain brought about via the terms of trade (which is of negligible importance). These advantages also dwarf any loss of 'consumer surplus', at least as estimated by Batchelor and Minford (1977). They also, in our judgement, are far larger than could be counteracted by any increase in prices charged by foreign exporters or domestic importers under a quota strategy.

It has become customary to refer to a protectionist strategy as 'the siege economy'. Under our assumptions the epithet is very inappropriate, since protection generates abundance, whereas a successful siege must result ultimately in starvation.

One final qualification should, however, be added, which may influence assessment of the very long-term consequences of alternative strategies. Under our assumptions a devaluation strategy *if successful* will, corresponding to a given level of domestic output and a given balance of payments, generate a higher level of both exports and imports and also of profits and investment than a successful protectionist strategy; this could ultimately mean a better long-term trend of productivity and some modification of the relatively poor performance of real income and prices following devaluation.

Year	1	2	3	4	5	6	7
A. Fiscal policy makes $X=M$ throughout							
(1) Tariffs compared with devaluation							
$\bar{Y}$	+3·4	+2·9	+1·5	0	0	0	0
Consumer prices	−5·6	−4·7	−3.5	−2·5	−3·1	−3·1	−3·1
(2) Quotas compared with devaluation							
$\bar{Y}$	+10·8	+9·0	+4·8	0	0	0	0
Consumer prices	−13·3	−7·8	−4·2	−0·9	−2·9	−2·9	−2·9
B. Fiscal policy puts t_{vat} immediately to its long-term value							
(1) Tariffs compared with devaluation							
Difference to change in prices is −3·1% throughout							
$\bar{Y}$	+1·9	+1·6	+0·9	+0·3	+0·1	+0·1	0
$X-M$ (£b.)	+0·4	+0·4	+0·2	−0·1	−0·1	0	0
(2) Quotas compared with devaluation							
Difference to change in prices is −2·7% throughout							
$\bar{Y}$	+4·1	+4·3	+2·8	+0·7	+0·2	+0·1	0
$X-M$ (£b.)	+1·9	+1·5	+0·7	−0·2	−0·1	0	0

APPENDIX A

This appendix gives a glossary for the symbols employed in the paper. The catalogue is arranged under the headings of control variables, parameters and baseline values, and endogenous variables.

Control variables:

- t_m rate of tariff on imports
- s_x rate of subsidy to exports
- t_{vat} rate of discretionary indirect tax
- $\bar{m}_q$ ex ante decrease in import volume, due to quotas
- t_m' rate of tariff applied selectively to imports entering domestic private expenditure.

Parameters and baseline values:

- **X*** 'base' value of exports
- **M*** 'base' value of imports
- **XP*** 'base' value of private expenditure
- τ_d marginal direct tax rate
- τ_i marginal net indirect tax rate
- v coefficient of response of import prices to tariffs
- u coefficient of response of export prices to subsidies
- η, ϵ price elasticity of demand for imports, exports
- ω weight of imports in cost of private expenditure and exports
- γ weight of consumption in private expenditure
- μ marginal propensity to import (relative to volume of real national output)
- a coefficient of private expenditure function
- ω' share of imports in costs of exports: for pure devaluation, we take $\omega'=\omega$; for pure tariffs we take $\omega'=0$.

Endogenous variables:

Here and below, symbols refer to *changes* in values at current prices (plain symbols) and at baseline prices (symbols with bars) compared with their baseline values. Prices (against a baseline normalised to unity) are denoted by the prefix Π. In the following list the word 'volume' means that the variable is measured at baseline prices.

- $\bar{X}$ volume of exports
- $\bar{m}$ ex ante change in volume of imports
- ΠX price of exports
- ΠM price of imports.
- TT terms of trade
- X value of exports
- $\bar{M}$ volume of imports
- M value of imports

B current balance of payments (value)
XP private expenditure (value)
$\overline{XP}$ volume of private expenditure
ΠXP price of private expenditure
Y value of real national output (GDP at factor cost)
$\overline{Y}$ volume GDP
YP value of private disposable income
$\overline{YR}$ volume of real national income
FCA value of factor cost adjustment
$\overline{FCA}$ volume of factor cost adjustment
SX value of export subsidy
TM value of tariff receipts
TV value of receipts from discretionary indirect tax
TD value of direct tax receipts.

APPENDIX B

The equations for the endogenous variables are presented here without discussion. The first nine equations are simple definitions. These are followed by expressions for the values of various tax receipts, and then by non-trivial relations among the remaining endogenous variables. The economic assumptions underlying these equations are discussed in CG and elsewhere.

$$Y=B+XP-FCA \quad \text{(A1)}$$
$$\overline{Y}=\overline{X}+\overline{XP}-\overline{M}-\overline{FCA} \quad \text{(A2)}$$
$$\overline{YR}=\overline{Y}+\mathbf{M}^*(TT-1) \quad \text{(A3)}$$
$$YP=Y-TD \quad \text{(A4)}$$
$$X=\overline{X}\ .\ \Pi X+\mathbf{X}^*(\Pi X-1) \quad \text{(A5)}$$
$$M=\overline{M}\ .\ \Pi M+\mathbf{M}^*(\Pi M-1) \quad \text{(A6)}$$
$$B=X-M \quad \text{(A7)}$$
$$TT=\Pi X/\Pi M \quad \text{(A8)}$$
$$\overline{XP}=[XP-\mathbf{XP}^*(\Pi XP-1)]/\Pi XP \quad \text{(A9)}$$
$$SX=s_x(\mathbf{X}^*+X) \quad \text{(A10)}$$
$$TM=t_m(\mathbf{M}^*+M) \quad \text{(A11)}$$
$$TV=t_{vat}(\mathbf{XP}^*+XP)\gamma \quad \text{(A12)}$$
$$TD=\tau_d Y \quad \text{(A13)}$$
$$\overline{FCA}=\tau_i\overline{XP} \quad \text{(A14)}$$
$$FCA=\overline{FCA}+TM+TV-SX \quad \text{(A15)}$$
$$\overline{M}=\overline{m}+\mu\overline{Y} \quad \text{(A16)}$$
$$XP_t=a\ .\ YP_t+(1-a)\ .\ YP_{t-1} \quad \text{(A17)}$$
$$\Pi M=1-vt_m \quad \text{(A18)}$$
$$\Pi X=1-us_x+\omega'(1-v)t_m \quad \text{(A19)}$$
$$\overline{m}_t=-\eta_t\mathbf{M}^*[\Pi M(1+t_m)-1] \quad \text{(A20)}$$
$$\overline{X}_t=-\epsilon_t\mathbf{X}^*(\Pi X-1) \quad \text{(A21)}$$
$$\Pi XP_t=[(\Pi M)(1+t_m)\omega+(1-\omega)]\ [1+\gamma t_{vat,t}] \quad \text{(A22)}$$

To a linearised approximation, (A22) becomes

$$\Pi XP_t=1+\omega(1-v)t_m+\gamma t_{vat,t} \quad \text{(A23)}$$

The price of private consumption (ΠC) is the same as equation (A23) without γ in the final term, so long as we assume the import content of private consumption is the same as that of total private expenditure.

APPENDIX C

Here we use the basic relations catalogued in Appendix B to derive the equations discussed in the main text.

This is done in two parts.

In *Part I*, we treat the policy variables t_m, s_x and $\overline{m}_q$ as being set to those constant, predetermined values which in the long run produce the desired change in output volume; a general indirect tax on all consumption $t_{vat,t}$, is fine-tuned so that the balance of payments remains unchanged at each time step, that is $B_t=0$ for all $t>0$. We thus derive expressions for the short-term dynamical behaviour of $\overline{Y}_t$ and of $t_{vat,t}$ en route to their long term goals.

In *Part II* all the policy variables t_m, s_x, $\overline{m}_q$ *and* t_{vat} are set to their constant final values in one step; their values are such as eventually to produce the desired value of $\overline{Y}_\infty$ in conjunction with $B_\infty=0$. In this case we give explicit expressions for the dynamical behaviour of $\overline{Y}_t$ and of B_t.

Throughout, we linearise in the policy variables; all terms involving the product of two or more of the quantities t_m, s_x, $\overline{m}_q$, t_{vat} are discarded. On the other hand the direct and indirect tax rates τ_d and τ_i are treated exactly.

Note that once we have expressions for $\overline{Y}_t$ and for the associated values of the policy variables (with t_{vat} itself being time-dependent in Part I), expressions for $\overline{YR}_t$ and for the price of private consumption follow. From equations (A3) (A8) (A18) and (A19), the linearised approximation for the volume of real national income is

$$\overline{YR}_t=\overline{Y}_t+(vt_m-us_x+\omega'[1-v]t_m)\mathbf{M}^* \quad \text{(A24)}$$

Part I: $B_t=0$

Throughout this first part, we take $B_t=0$ (i.e. $X=M$ at each time step), with this constraint being maintained by appropriate control of $t_{vat,t}$.

Substituting from equation (A5) for X, we can rewrite equation (A6) as

$$\overline{M}=[\overline{Y}\cdot\Pi X+\mathbf{X}^*(\Pi X-1)-\mathbf{M}^*(\Pi M-1)]/\Pi M \quad \text{(A25)}$$

Thence equation (A16) reads

$$\mu\overline{Y}_t=-\overline{m}_t+\overline{X}_t\cdot TT+\mathbf{X}^*(\Pi X-1)/\Pi M -\mathbf{M}^*(\Pi M-1)/\Pi M \quad \text{(A26)}$$

We now substitute equations (A18) (A19) (A20) and (A21) for $\overline{m}_t$, $\overline{X}_t$, ΠX and ΠM, to obtain (given the constraint $B_t=0$)

$$\mu \overline{Y}_t = t_m \mathbf{M}^*[\eta_t(1-v)+v/(1-vt_m)] + [us_x-\omega'(1-v)t_m] \mathbf{X}^*[\epsilon_t(1-[us_x-\omega'(1-v)t_m])-1]/(1-vt_m). \quad (A27)$$

Under the linearised approximation discussed above this becomes

$$\mu \overline{Y}_t = t_m \mathbf{M}^*[v+\eta_t(1-v)] + \mathbf{X}^*[\epsilon_t-1][us_x-\omega'(1-v)t_m] \quad (A28)$$

In the long run, once time delays in the volume responses of exports and imports have worked their way through the system, this gives

$$\mu \overline{Y}_\infty = t_m \mathbf{M}^*[v+\eta(1-v)] + \mathbf{X}^*[\epsilon-1][us_x-\omega'(1-v)t_m] \quad (A29)$$

Here ϵ and η are the asymptotic values of ϵ_t and η_t. This important formula gives the basic relationship between the long-term change in volume of real national output, and the associated values of the export subsidy and import tariff rates.

It remains to determine the value of $t_{vat,t}$ required, at each time step, to maintain $B_t=0$.

As a first step, subtract equation (A2) from equation (A1) to get

$$Y-\overline{Y}=(X-\overline{X})-(M-\overline{M})+(XP-\overline{XP}) -(FCA-\overline{FCA}) \quad (A30)$$

Using the linearised versions of equations (A5) (A6) and (A9), this gives

$$Y-\overline{Y}=\mathbf{X}^*(\Pi X-1)-\mathbf{M}^*(\Pi M-1) +\mathbf{XP}^*(\Pi XP-1)-(TM+TV-SX) \quad (A31)$$

In conjunction with the explicit expressions given earlier for ΠX, ΠM, ΠXP, TM, TV and SX, this leads to the conclusion that the right-hand side in equation (A31) is a constant:

$$Y_t-\overline{Y}_t=\Omega \quad (A32)$$

Here the constant Ω is defined to be

$$\Omega=[(1-u)s_x+\omega'(1-v)t_m]\mathbf{X}^*+(1-v)t_m(\omega\mathbf{XP}^*-\mathbf{M}^*) \quad (A33)$$

Next we note that, from equation (A23), the linearised version of equation (A9) is

$$\overline{XP}=XP-\mathbf{XP}^*[\omega(1-v)t_m+\gamma t_{vat}] \quad (A34)$$

Then from equations (A1), (A15) and (A14), it follows for $B_t=0$ (as throughout Part I) that

$$Y=XP-\overline{XP}\,\tau_i-TM-TV+SX \quad (A35)$$

That is

$$Y_t=XP_t(1-\tau_i)-\gamma\mathbf{XP}^*(1-\tau_i)t_{vat,t}-t_m\mathbf{M}^* +s_x\mathbf{X}^*+\tau_i\omega\mathbf{XP}^*(1-v)t_m \quad (A36)$$

Finally, we combine equations (A17), (A4) and (A13) to get

$$XP_t=(1-\tau_d)[\alpha Y_t+(1-\alpha)Y_{t-1}] \quad (A37)$$

Equation (A36) can now be expressed as a relation between $t_{vat,t}$ and Y_t. Alternatively, using equation (A32), the relation is between the desired value of $t_{vat,t}$ and $\overline{Y}_t$, the latter being known from equation (A28). Thus at last we have

$$\gamma\mathbf{XP}^*(1-\tau_i)t_{vat,t}=-(1-\alpha T)\overline{Y}_t+(1-\alpha)T\overline{Y}^\dagger_{t-1} +s_x\mathbf{X}^*-t_m\mathbf{M}^*+\tau_i\omega\mathbf{XP}^*(1-v)t_m-(1-T)\Omega \quad (A38)$$

Here Ω is given by equation (A32), and the superscript 'dagger' on $\overline{Y}_{t-1}$ is to denote the definition that

$$\overline{Y}^\dagger_0=-\Omega \quad (A39)$$

(which makes for notational simplicity in equation (A38)). Likewise for notational convenience we have introduced

$$T=(1-\tau_i)(1-\tau_d) \quad (A40)$$

In the long run, we can use the asymptotic value $\overline{Y}_\infty$ in equation (A38), to get the indirect tax rate needed to keep $B=0$ once the system has settled to equilibrium:

$$[\gamma\mathbf{XP}^*(1-\tau_i)]t_{vat,\infty}=-[1-T]\overline{Y}_\infty +(a_1s_x-a_2t_m)(1-\tau_i)\gamma\mathbf{XP}^* \quad (A41)$$

Here Y_∞ is given by equation (A29), and the constant coefficients a_1 and a_2 are defined to be

$$(1-\tau_i)\gamma\mathbf{XP}^*a_1=[u+(1-u)T]\mathbf{X}^* \quad (A42)$$

$$(1-\tau_i)\gamma\mathbf{XP}^*a_2=[v+(1-v)T]\mathbf{M}^* + \omega\mathbf{XP}^*(1-v)(1-\tau_i)\tau_d+\omega'\mathbf{X}^*(1-v)(1-T) \quad (A43)$$

T is given by equation (A40).

Using this equation (A41) for the asymptotic indirect tax rate, we can express equation (A38) in a simpler form as

$$t_{vat,t}=t_{vat,\infty}+\chi[(1-T)\overline{Y}_\infty -(1-\alpha T)\overline{Y}_t+(1-\alpha)T\overline{Y}_t{}^\dagger{}_{-1}] \quad (A44)$$

Here χ is the quantity

$$\chi=1/[\gamma\mathbf{XP}^*(1-\tau_i)] \quad (A45)$$

This derivation has perforce been a bit of a mess. Nevertheless, the essential results are clear. The *long-term* relations between the targeted values of $\overline{Y}$ and B, and the policy variables needed to attain those targets, are given by equation (A29) for $\overline{Y}_\infty$ and equation (A41) for the concomitant VAT rate needed to maintain $B=0$.

The *short-term* dynamics of $\overline{Y}_t$ are described by equation (A28), and the corresponding short-term behaviour of the VAT rate (fine-tuned to keep $B_t=0$ at each time step) follows from equation (A44).

Part II: t_{vat} is constant

We now turn to the case where all policy variables, including the VAT rate, are set to constant values, chosen to produce a given long-term change in $\overline{Y}$ accompanied by no long-term change in the balance of payments, $B_\infty=0$.

The relations between the targeted asymptotic values of $\overline{Y}_\infty$ and B_∞, and the policy variables t_m, s_x, $\overline{m}_q$ and t_{vat} are of course as described above by equation (A29) for $\overline{Y}_\infty$ and equation (A41) for the indirect tax rate corresponding to $B_\infty=0$.

Part II differs from Part I in that t_{vat} is held constant, and consequently B_t manifests short-term dynamical behaviour on its way to its asymptotic value of zero: this contrasts with Part I, where B_t is held constant at zero, and the indirect tax rate exhibits time-dependence.

It is worth emphasising that the short-term behaviour of $\overline{Y}_t$ referred to throughout Part II is slightly different from that in Part I (by virtue of the different policy constraints); that is, the equations for $\overline{Y}_t$ are different. But the long-term value $\overline{Y}_\infty$ is common to the two parts.

For an equation connecting $\overline{Y}_t$ and B_t, we begin by returning to equation (A35), and noting that an additional term $+B_t$ should be inserted on the right-hand side (RHS) if $B_t \neq 0$. The subsequent manipulations, which use equations (A34) and (A37) to replace $\overline{XP}$ and XP with Y in equation (A35), and then use equation (A32) to replace Y with $\overline{Y}$, may be carried out as above, *mutatis mutandis*. The result, as before, is equation (A38), but with two alterations: first, there is an additional term $+B_t$ on the RHS; second, the indirect tax rate is not time-dependent, but is constant, equal to the asymptotic value given by equation (A41). Substituting from equation (A41) into the altered equation (A38), and rearranging, we get

$$(1-aT)\overline{Y}_t=(1-a)T\overline{Y}_t{}^{\dagger}{}_{-1}+B_t+(1-T)\overline{Y}_{\infty} \qquad \text{(A46)}$$

Here T is as defined by equation (A40), $\overline{Y}_{\infty}$ is given by equation (A29), and, as before, the dagger on $\overline{Y}^{\dagger}$ denotes that $\overline{Y}^{\dagger}{}_0=-\Omega$ (as specified by equation (A39)); this convention is motivated by the desire for compact notation in equations (A38) and (A46)).

In order to obtain an explicit expression for the dynamical behaviour of $\overline{Y}_t$ under a constant indirect tax rate, we need to eliminate B_t in equation (A46). To do this, note that from the definition (A7)

$$B_t=X_t-M_t. \qquad \text{(A47)}$$

From the linearised versions of equations (A5) and (A6), this becomes

$$B_t=\overline{X}_t-\overline{M}_t+\mathbf{X}^*(\Pi X-1)-\mathbf{M}^*(\Pi M-1), \qquad \text{(A48)}$$

Or, using equations (A16) (A18) and (A19)

$$B_t=-\mu\overline{Y}_t+[\overline{X}_t-\overline{m}_t-(us_x-\omega'[1-v]t_m)\mathbf{X}^* + vt_m\mathbf{M}^*] \qquad \text{(A49)}$$

The term in square brackets is immediately recognisable as the expression for the time-dependent changes in volume of real national output in Part I, equation (A28). To avoid confusion between this expression for volume output with the VAT rate fine-tuned to keep $B_t=0$, and the present Part II expression for $\overline{Y}_t$ with constant indirect tax rate, we re-christen the former as ϕ_t:

$$\mu\phi_t=\overline{m}_q+\mathbf{X}^*[\epsilon_t-1][us_x-\omega'(1-v)t_m] + \mathbf{M}^*t_m[v+\eta_t(1-v)] \qquad \text{(A50)}$$

(cf. equation (A28)). Then equation (A49) reads

$$B_t=\mu(\phi_t-\overline{Y}_t) \qquad \text{(A51)}$$

Notice that of course $\phi_{\infty}=Y_{\infty}$ (cf. equation (A29)), and thus $B_{\infty}=0$, as it should.

Substituting equation (A51) into equation (A46), and rearranging, we finally obtain an expression for the short term dynamical behaviour of $\overline{Y}_t$ under a constant indirect tax rate:

$$\overline{Y}_t=\frac{(1-T)\overline{Y}_{\infty}+(1-a)T\overline{Y}^{\dagger}{}_{t-1}+\mu\phi_t}{(1-aT+\mu)} \qquad \text{(A52)}$$

This expression is to be read in conjunction with the definitions (A29), (A39), (A40) and (A50).

With the value of Y_t determined by equation (A52), the short term dynamical behaviour of the balance of payments under a constant indirect tax rate is given by equation (A51).

In short, under a policy of a constant indirect tax rate, the long-term relationship between Y and B $(=0)$, and the policy instruments t_m, s_x, $\overline{m}_Q$ and t_{vat}, are as before given by equations (A29) and (A41). The short-term dynamical response of $\overline{Y}_t$ is described by equation (A52), and of B_t by equation (A51).

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