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Imperfect Competition in an Open Economy

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ECONOMICS DEPARTMENT

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Imperfect Competition in an Open Economy

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ABSTRACT

This paper describes a simulation model of a small open economy, which includes a careful specification of imperfect competition in the goods market and the possibility of increasing returns to scale of goods production. The response of the model to shocks is investigated on the assumption that the policy authorities seek to control inflation by means of a fixed nominal exchange rate target and to maintain zero net external debt by means of a simple fiscal policy rule. The influence of economies of scale on the pattern of response to shocks is investigated.

August 1990

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1. Introduction

The development of models of imperfect competition (Hart, 1982, Weitzman, 1982, Meade, 1986, Pagano, 1990) has led to a new interest in the importance of economies of scale. However, these studies have typically been algebraic models which, while often complete in their own terms, typically do not represent all the interactions believed to be important in the macroeconomy. As a consequence it is difficult to use such models to quantify the importance of economies of scale and to identify the extent to which they differ in practice from those with constant returns.

In this paper we set out a simulation model of an open economy with economies of scale, in order to investigate this issue. It has two distinctive characteristics:

- (i) a framework of imperfect competition between firms. As firms enter (or exit) production, depending on the earnings yield and the cost of capital, the profit mark-up is revised. As Layard and Nickell (1985) note, a lower mark-up during a demand boom shifts the labour demand outwards and generates a rise in output. With new investment to face the rising production requirements, the capital stock increases and this causes further changes to the composition of wealth and to the demand for other assets.
- (ii) a production function with possibly increasing returns to scale, so that labour and capital productivity rise with rising activity.

This allows us to investigate the importance of economies of scale as the economy responds to exogenous disturbances.

The model is too complex for analytic solution, although an analytic investigation of its steady-state properties is possible. We therefore simulate our theoretical model using parameter values relevant to a small open economy such as Britain's.

As with any model, the response to disturbances cannot be considered independently of the framework of macroeconomic policy. We adopt a structure which is intended to mimic the behaviour of a country in a fixed nominal exchange rate system, but which, like Britain, is explicitly concerned about the current account on its balance of payments. Accordingly, we assume that the authorities seek to keep the exchange rate close to its fixed target by means of intervention in the foreign exchanges. However reserves are limited, and the interest rate is adjusted with the aim of keeping foreign exchange reserves close to a target level. Fiscal

policy is set with reference to the country's net foreign asset position.¹ In this paper, we assume that government spending is set by long-run considerations about the desirability of public spending, so that fiscal policy is then represented by variations in the tax rate.

The rest of the paper is organised as follows. Section 2 describes the equations of the model and the values that were imposed on the parameters. Section 3 presents the steady-state solution and examines the links between target choices, instrument levels and consistent equilibrium values for real exchange rates. Section 4 describes the details of the fiscal policy and monetary policy and then presents simulations of the model by looking at the behaviour of the main economic variables. Finally Section 5 concludes with possible applications of, and extensions to, the present model.

2. The Model

2.1 Main Features

This section describes the model in detail. It is intended to provide a complete description of a small open economy; its imposed coefficients take values typical of those observed for the UK. Consistent stock-flow accounts are kept² and the effects of valuation changes on wealth are recorded. These are driven by exchange rate changes (which satisfy capital market equilibrium conditions) and by an arbitrage model of the valuation of securities on the stock exchange (the valuation ratio).

Expectations of future exchange rate changes are forward-looking but the exchange rate is nevertheless stabilised by official intervention. The valuation ratio, Tobin's Q, is treated as a forward-looking variable which is free to react to unanticipated shocks or policy announcements on the assumption of model-consistent expectations (perfect foresight). It influences the economy not only by leading to capital gains and losses which influence wealth and thus consumption, but also as a determinant of new investment. This provides a channel for interest rate effects quite different from that found in most macroeconomic models.³

¹ We are, of course, aware that every country in the world cannot achieve independently-chosen values for net foreign assets. But we are modelling a small country, taking the rest of the world as given.

² The importance of this is stressed by Sargent and Wallace (1981) and Whittaker, Wren-Lewis, Blackburn and Currie (1986), following from the work of Blinder and Solow (1973).

³ In the UK Treasury model, for example, interest rates exert their main influence by their impact on the money stock (Westaway and Whittaker, 1986).

A novel feature of the model is that we introduce a coherent framework of imperfect competition. The mark-up depends on the number of firms as described by Meade (1986); this number in turn rises or falls as the valuation ratio exceeds or is below its equilibrium value of 1. With the valuation ratio satisfying an arbitrage equation, the implication of this is that the number of firms rises or falls depending on whether expected profits per unit of capital, discounted at the expected interest rate, exceed or are below the unit price of capital. Such a model can be accommodated in a situation in which the production function of each firm reflects increasing returns to scale.

Finally, we assume that there is no single natural rate of unemployment, but that real wages rise in response to a fall in unemployment and fall in response to a rise in unemployment, as described by Lawson (1982). Such a model, then accommodates the hysteresis effects noted by Budd, Levine and Smith (1988). However, we show that it can in fact be integrated to give a conventional model with a rising labour supply curve.

We now set out our notation and the equations of the model. The theory underlying each of this is explained subsequently.

2.2 Notation

Table 2.1

Subscripts

Superscripts

Notation

t gives value of variable during t^{th} quarter.

∞ gives steady-state value of variable.

Absence of subscript marks a constant term, or equilibrium.

\sim money value of variable in domestic currency

$\$ \sim$ money value of variable in foreign currency.

* target value of variable

- base line value of variable

F foreign term corresponding to similar domestic term.

P private-sector variable

G government sector variable

X export term

M import term

$x_{t, t+1}^e$ value of variable X expected during period t , to rule during period $t+1$.

Variables other than the money price variables (P , P^X , P^M , P^E , W), the ratios (R , R^F , Z , E , Q), the amount of foreign imports (M), and the number of firms (N) are all valued in terms of the domestic product (i.e. with money values deflated by the domestic price level P) unless they have the superscript $\tilde{\sim}$ or $\tilde{\$}$.

Greek characters represent constant parameter values unless otherwise stated. Lower case Roman characters will be used occasionally to express variables measured per firm (i.e. the aggregates divided by N). The following variables are defined:

List of Variables

<u>Name</u>	<u>Definition</u>	<u>Baseline Value</u>
A	Stock of Bonds	0
B	Budget Deficit	0
C^P	Private Sector Consumption	60
C^G	Government Expenditure	14
D	Stock of Money	25
E	Exchange Rate (Foreign Price of Sterling)	1
F	Official Intervention	0
G	GDP	80
H	Total Stock of Foreign Wealth	0
H^G	Stock of Reserves	0
H^P	Private Sector Stock of Foreign Wealth	0
I	Gross Investment	6
J	Balance of International Payments on Current Account	0
K	Real Capital Stock	1000
L	Employment	100
M	Imports	20
N	Number of Firms	1000
P	General Price Level	1
P^F	World Prices of Finished Goods in Foreign Currency	1
P^X	Export Prices	1
P^M	Import Price of Raw Materials, in Foreign Currency	1
Q	Capital Valuation Ratio	1
R	Domestic Interest Rates	0.02 (= 8% p.a.)
R^F	Foreign Interest Rates	0.02 (= 8% p.a.)
S	Payroll Tax Rate	0.35
T	Trade Balance	0
U	National Debt	25
V	Total Private Wealth	1025
W	Nominal Wage Rate, Net of tax	0.40
X	Exports	20
Y	Domestic Output	100
Y^E	Volume of Foreign Demand	100
Z	Earnings Yield	0.02 (= 8% p.a.)

Table 2.2

The Equations

$$C_t^P = \alpha_1 \frac{L_t^W}{P_t} + \alpha_2 V_t \quad (1)$$

$$X_t^* = \beta_0 Y^F + \beta_1 \left[\frac{P^F}{E_t P_t^X} - 1 \right] \quad (2a)$$

$$\Delta X_t = \lambda_1 (X_t^* - X_{t-1}) \quad (2b)$$

$$M_t = \beta_2 Y_t \quad (3)$$

$$\frac{Y_t - M_t}{N_t} = \gamma_0 \left[\frac{L_t}{N_t} \right]^{\gamma_1} \left[\frac{K_t}{N_t} \right]^{\gamma_2} \quad (4a)$$

$$L_t^{\gamma_1} = \left[\frac{1 - \beta_2}{\gamma_0} \right] Y_t K_t^{-\gamma_2} N_t^{-(\gamma_1 + \gamma_2 - 1)} \quad (4b)$$

$$\Delta(L_t/N_t) = \lambda_5 (L_t^*/N_t - L_{t-1}/N_{t-1}) \quad (4c)$$

$$\tilde{T} = X_t P_t^X - \frac{P^M}{E_t} M_t \quad (5a)$$

$$T = \frac{P^X}{P_t} X_t - \frac{P_t^M}{E_t P_t} \beta_2 Y_t \quad (5b)$$

$$\Delta N_t = \psi_1 (Q_t - \bar{Q}) \quad (6)$$

$$\Delta \left[\frac{K_t}{N_t} \right] = \lambda_3 \left[\frac{\gamma_2}{(\gamma_1 + \gamma_2) N_t} \frac{G_t}{(R_t + \psi_2)} - \frac{K_{t-1}}{N_{t-1}} \right] \quad (7)$$

$$I_t = \Delta K_t + \psi_2 K_{t-1} \quad (8)$$

$$Y_t = C_t^P + C^G + I_t + X_t \quad (9)$$

$$\frac{W_t}{W_{t-1}} = \left[\frac{L_{t-1}}{L_{t-2}} \right]^{\xi_1} \left[\frac{P_t}{P_{t-1}} \right]^{\xi_3} \left[\frac{P_{t-1}}{P_{t-2}} \right]^{1-\xi_3} \quad (10)$$

$$P_t^* = \left[1 + \frac{\epsilon}{N_t} \right] \left[(1 + S_t) \frac{W_t L_t}{Y_t} + \beta_2 \frac{P_t^M}{E_t} \right] \quad (11a)$$

$$\Delta P_t = \lambda_4 (P_t^* - P_{t-1}) \quad (11b)$$

$$P_t^X = \beta_3 P_t + (1 - \beta_3) \frac{P_t^F}{E_t} \quad (12)$$

$$G_t = C_t^P + C_t^G + I_t + T_t \quad (13)$$

$$E_t P_t J_t = E_t P_t T_t + R^F E_{t-1} P_{t-1} H_{t-1} \quad (14a)$$

$$J_t = T_t + R^F \frac{E_{t-1} P_{t-1}}{E_t P_t} H_{t-1} \quad (14b)$$

$$E_t P_t H_t = E_{t-1} P_{t-1} H_{t-1} + E_t P_t J_t \quad (15a)$$

$$H_t = J_t + \frac{E_{t-1} P_{t-1}}{E_t P_t} H_{t-1} \quad (15b)$$

$$H_t = H_t^P + H_t^G \quad (16a)$$

$$H_t^G = H_t - H_t^P \quad (16b)$$

$$\tilde{\$} H_t^{P*} = \left[\phi_1 - \phi_2 \left[R_t - R^F + \frac{E_{t,t+1}^e - E_t}{E_t} \right] \right] \tilde{\$} V_t \quad (17a)$$

$$\Delta \tilde{\$} H_t^P = \lambda_2 \left[\tilde{\$} H_t^{P*} - \tilde{\$} H_{t-1}^P \right] \quad (17b)$$

$$H_t^P = \lambda_2 \left[\phi_1 - \phi_2 \left[R_t - R^F + \frac{E_{t,t+1}^e - E_t}{E_t} \right] \right] V_t$$

$$+ (1 - \lambda_2) \frac{E_{t-1}^P P_{t-1}}{E_t P_t} H_{t-1}^P \quad (17c)$$

$$E_t^P H_t^G = E_{t-1}^P H_{t-1}^G + E_t^P F_t \quad (18a)$$

$$F_t = H_t^G - \frac{E_{t-1}^P P_{t-1}}{E_t P_t} H_{t-1}^G \quad (18b)$$

$$\tilde{B}_t = \left[P_t C_t^G - S_t W_t L_t \right] + R_{t-1} \tilde{A}_{t-1} - R_{t-1}^F \frac{E_{t-1}}{E_t} \tilde{H}_{t-1}^G \quad (19a)$$

$$\tilde{B}_t = \Delta \tilde{A}_t + \Delta \tilde{D}_t \quad (19b)$$

$$A_t = \left[C_t^G - \frac{S_t W_t L_t}{P_t} \right] + \frac{1 + R_{t-1}}{P_t / P_{t-1}} A_{t-1} - R_{t-1}^F \frac{E_{t-1}^P P_{t-1}}{E_t P_t} H_{t-1}^G - \left[D_t - \frac{P_{t-1}}{P_t} D_{t-1} \right] \quad (19c)$$

$$U_t = A_t + D_t - H_t^G \quad (20)$$

$$V_t = A_t + D_t + H_t^P + Q_t K_t \quad (21a)$$

$$V_t = H_t + U_t + Q_t K_t \quad (21b)$$

$$D_t = \delta_1 V_t + \delta_2 Y_t - \delta_3 R_t \quad (22)$$

$$Z_t = \frac{\tilde{G}_t - (1+S)W_t L_t - \psi_2 P_t K_{t-1}}{Q_{t-1}^P P_{t-1} K_{t-1}} \quad (23)$$

$$\frac{1 + R_t}{P_t / P_{t-1}} = Z_t + \frac{Q_{t+1,t}^e}{Q_t} \quad (24a)$$

$$\frac{Q_{t+1,t}^e}{Q_t} = \frac{1 + R_t}{P_t/P_{t-1}} - Z_t \quad (24b)$$

2.3 The Model Specified

Demand and Supply

The consumption function shows spending out of private wealth and labour income (equation 1). It represents life-cycle behaviour when current labour income is taken as representative of future labour income. Equations 2 and 3 show trade flows. Export demand is seen as price-sensitive,⁴ adjusted with a lagged response so as to produce a J-curve. Imports on the other hand are treated as being confined to raw materials. The quantity of the material (M), which is needed to produce one unit of the finished domestic product (Y) is technically fixed at β_2 (equation 3). Equation (4a) is a neoclassical Cobb-Douglas production function for each firm. Value added per firm $(Y - M)/N$ is determined by the capital and labour inputs used by the firm. All firms use the same technology with no exogenous technological progress. Technical coefficients are fixed and such that $\gamma_1 + \gamma_2 > 1$ ensuring increasing returns to scale, while the constant γ_0 is used for scaling the numerical values. Having assumed that material inputs are a fixed proportion of the final product, the equation can be used to derive the aggregate demand for labour in terms of output, and fixed capital (equation 4b). Equation 4c gives the partial adjustment process for employment by each firm.

The trade balance is described by equation 5. Equation (3) is substituted into (5a) to give equation (5b).

Domestic goods markets are assumed to be represented by a form of imperfect competition. The underlying model is spatial in form. Firms are assumed to be distributed at equal intervals round a circle, while consumers represent a continuum on the circle. Firms face transport costs in distributing goods to consumers, but their local monopoly power allows them to earn excess profits on sales to all except their marginal consumers. The process of competition ensures that, in equilibrium, the number of firms adjusts so that, despite the opportunities for excess profit afforded by local monopoly, the return on capital is equated to the rate of interest. This model is described by Meade (1986).

There are two aspects to investment, represented by equations (6) and (7). Equation

⁴ We have made the foreign demand for our exports depend upon the prices charged to them (P^*) and not one the price charged to domestic purchasers (P) and have written an additional equation - in (12) - to express the value of P^* .

(6) represents the fact that, if the average valuation ratio is greater than 1, there is an incentive to set up new firms. With quadratic adjustment costs, the rate of change of the number of firms will be given by (6) (Hayashi, 1982). But it should be noted that this function relates to average Q and the setting up of new firms. It is therefore equally valid with constant or increasing returns to scale.⁵ This mechanism is forward-looking, unlike that described by Pagano (1990). He assumes that the number of firms adjusts in response to current profits only.

Secondly, it is assumed that each firm follows a partial adjustment process. Equation (7) shows the capital stock per firm adjusting in response to the difference between its previous value and the level of capital per firm consistent with profit maximisation at current output and interest rate levels. This profit-maximising level of the capital stock can be derived in the following way.

First, total costs should equal total revenue:

$$wL + (R + \psi_2)K + P^M M/E = P(Y - X) + P^X X \quad (26)$$

Recalling (3), (5b) and (13) and dividing all terms by the number of firms N we find that for each firm with Z the earnings yield on capital and ψ_2 the rate of depreciation, the value of labour and capital inputs add to nominal value added:

$$(1 + S)W(L/N) + (ZQ + \psi_2)P(K/N) = P(G/N) \quad (27)$$

For a given output level per firm (that is $Y/N = y' = \text{constant}$) the firm in the long run chooses the variable input factors ($l=L/N$) and ($k=K/N$) in order to minimise cost. The Lagrangian is :

$$\Lambda = (1 + S)Wl + (ZQ + \psi_2)Pk + \lambda\{Y/N - y'\} \quad (28)$$

with λ denoting the shadow cost of one additional unit of output per firm.

By taking first-order conditions we find that the unit prices of input factors should be proportional to their marginal products, which are in turn is proportional to the average products and their factor elasticities:

$$(1+S)W = \lambda \frac{\partial(Y/N)}{\partial l} = \lambda \gamma_1 \frac{(Y/N)}{l} \quad (29a)$$

$$(ZQ + \psi_2)P = \lambda \frac{\partial(Y/N)}{\partial k} = \lambda \gamma_2 \frac{Y/N}{k} \quad (29b)$$

⁵ As Hayashi (1982) notes, with a conventional Q -driven investment function there is always the problem that marginal Q is relevant while average Q is observed. Our specification, suggested by James Meade, avoids this problem.

Putting (29a and b) into (27) we find that

$$\lambda(\gamma_1 + \gamma_2)Y = PG$$

and hence that the shares of total cost paid to factor inputs are given in the long run optimum as:

$$(1 + s)w_l^* = \frac{\gamma_1}{\gamma_1 + \gamma_2} P (G/N) \quad (30)$$

$$(ZQ + \psi_2)k^* = \frac{\gamma_2}{\gamma_1 + \gamma_2} (G/N) \quad (31)$$

Equation (27) is automatically satisfied in equilibrium, as can be checked from the definition of the earnings yield in equation (23). Hence when the capital stock reaches the optimal level implied by (31), labour demand also reaches its optimal level as implied by (30), because these two equations add-up to (27).

In the steady-state the number of firms must be constant. Equation (6) implies that, for this to happen, the valuation ratio must be at its steady state value, ($Q = 1$). But if Q is constant, the profit rate must be equal to the rate of interest, by virtue of the arbitrage equation (24a). With $Z = R$ and $Q = 1$, (31) gives the target capital stock described in (7) towards which firms are gradually adjusting via a simple process.

In this framework firms minimise cost in the long run. In the short run firms may enter or exit production according to whether valuation ratio is lower or higher than its equilibrium value. Such deviations are in fact indications of differentials between the real rate of interest and the profit rate, as can be seen from (24b). In equilibrium these rates are equalised and there is no motive for a firm to enter or exit the economy.

Changes in the capital stock are added to depreciation of last period capital stock of each firm to give gross investment (8). Gross output (9) is the sum of the components of final demand.

Prices and Wages

Equation (10) determines the take-home wage rates. The model which we have used does not have a fixed natural rate of unemployment. Instead we have incorporated the idea that people who have been unemployed for any length of time drop out of the labour market (Budd, Levine and Smith, 1988) and, conversely that, once the unemployed are persuaded to work, they become more employable. As a consequence it is the change in unemployment rather than the level which leads to pressure on real wages (Lawson, 1982). We have placed a lag on this

process to represent adaptive expectations in the labour market. The wage equation, nevertheless, has the property that it integrates into the form which we would be found if the labour market were represented by a situation in which, in the long run, labour supply is increasing in the real wage. This is discussed in section 3.

A target price is defined by equation (11a). We prove that this price maximises profits when the firm sells in an imperfectly competitive market. In the short run the only variable costs per unit of product are wages and raw materials. The cost of capital is part of the fixed cost. When a firm produces y units of output, total cost will be given by:

$$c(y) = c_1 + c_2 y \quad (32)$$

where

$$c_2 = (1 + S)W(l/y) + \beta_2(P^M/E) \quad (33)$$

Profits per firm are

$$\pi = Py - (c_1 + c_2 y) \quad (34)$$

and are maximised when the firm sets production such that:

$$\partial\pi/\partial y = 0$$

or after some trivial manipulation:

$$P \left(1 + \frac{\partial P/P}{\partial y/y} \right) = c_2 \quad (35)$$

With output produced by other firms denoted by $Y' = Y - y$, and assuming a downwards sloping aggregate demand curve of constant elasticity $(-\epsilon)$, we can derive the symmetric Cournot-Nash solution as:

$$P^* = \frac{c_2}{1 - \epsilon/N} = \frac{(1+S)W(l/y) + \beta_2(P^M/E)}{1 - \epsilon/N} \quad (36)$$

For large N we can write the approximation

$$(1 - \epsilon/N)^{-1} \sim 1 + \epsilon/N \quad (37)$$

as in equation (11a) and interpret the pricing strategy as a mark-up on variable costs as described by Meade (1986). The mark-up is inversely proportional to the number of firms. It becomes zero under perfect competition ($N \rightarrow \infty$), and maximum when there is monopoly ($N = 1$) or complete collusion among firms. In our model we have assumed that gradual adjustment towards this target price level takes place. This is represented in equation (11b). Profit margins, in this model move to an equilibrium because, as noted before, if the rate of return on capital is greater than the rate of interest, new firms will enter, depressing the rate of return through increased competition.

As a result of the assumption that all imports take the form of raw materials embedded in domestic finished products, and that there is no value-added tax, there is no distinction

between the market price of domestic product and the cost of living (P). Export prices (12) are fixed as a weighted average of domestic and prices of competitors in foreign markets.

Real Income (13) is the sum of domestic demand at constant prices plus the real net trade balance: Multiplied by the price level (P) this gives gross domestic product at market prices ($P_t G_t$). To obtain Money GDP at factor cost one has to deduct indirect taxes.

$$GDP_t = P_t G_t - S_t W L_t \quad (38)$$

since, in the model it is assumed that all tax is raised as a payroll tax.

The External Sector

The real current balance is derived either in (14) as the sum of the real trade balance and real net property income from abroad or in (15a) as the change in foreign wealth at constant prices. It is assumed that all foreign borrowing or lending is denominated in foreign currency and that foreigners do not own any domestic assets. All foreign assets are assumed to take the form of bills on which there are no foreign currency capital gains, though a change in the exchange rate will cause a capital gain or loss in terms of the home currency. The stock of total foreign assets is obtained in (15b) by adding current balance plus revaluations on the existing stock of assets. This equation may be interpreted as the external constraint since it determines the changes in foreign assets required to finance a current account deficit or induced by a current account surplus.

The total national holding of foreign wealth, (16a), is held either by the government as foreign exchange reserves or by the private sector.

The private sector is assumed (17) to have a "target" holding of foreign assets expressed as a proportion of its total wealth. The proportion is sensitive to the expected excess yield on foreign assets, that is to the interest rate differential adjusted for expected changes in the foreign exchange rate. The actual holding adjusts gradually to the target holding according to (17c).

A Floating Exchange Rate

Equations (16-18) have implicitly described a fixed exchange rate system in which the capital account is cleared by foreign exchange intervention. We now set out how these equations could cope with an environment in which there is no intervention, and the exchange rate is therefore left to float. In the absence of official intervention ($F = 0$) foreign exchange reserves are adjusted only by revaluation effects:

$$H_t^G = \frac{E_{t-1}^P}{E_t^P} \frac{t-1}{t} H_{t-1}^G \quad (18c)$$

and foreign assets of the private sector are obtained as the accounting residual

$$H_t^P = H_t + H_t^G \quad (16c)$$

The floating exchange rate is determined in the capital markets in order to clear these changes in the portfolio holdings of the private sector. Reversing equation (17c) we obtain for the exchange rate:

$$\frac{E_{t,t+1}^e - E_t}{E_t} = R^F - R_t + \frac{1}{\phi_2 \lambda_2 V_t} \left[\phi_1 \lambda_2 V_t + (1 - \lambda_2) \frac{E_{t-1}^P}{E_t^P} H_{t-1}^P - H_t^P \right] \quad (17d)$$

and solving for the current period we arrive at exchange rate equation (17d). With perfect capital mobility ($\phi_2 \rightarrow \infty$) the above equation is reduced to the familiar uncovered interest-rate parity condition:

$$\frac{E_{t,t+1}^e - E_t}{E_t} = R^F - R_t \quad (17e)$$

A more complicated stock-flow adjustment takes place when official intervention (F) is actively used in order to achieve a nominal exchange rate target, as described in more detail in a next section. In such a case foreign exchange reserve (H^G) are adjusted in each period according to the amount of intervention and revaluations on last-period stock (equation 18b). Finally, the foreign assets of the private sector (H^P) are determined by the accounting identity (16c), while the exchange rate is clearing the market through (17d).

Other Stock-flow Relations

We move now to discuss the remaining stock-flow relations. The current budget deficit (19a) is comprised of the primary deficit between expenditure and taxation, plus interest payments on issued bonds, less any interest receipts from foreign assets held by the government.⁶ For convenience it is assumed that the deficit is either bond or money financed, so that the government budget constraint (19b) is satisfied.

With the stock of money determined by demand, we can obtain the stock of bonds in

⁶ Capital gains are not explicitly shown here, since they are taken into account in equations (15) and (18).

each period (19c). The last bracket expression in the right-hand-side of (19c) shows how the government can reduce the real stock of bonds through seigniorage and inflation effects. Using \hat{P} and \hat{D} for the rate of inflation and the real growth rate of the money stock respectively, we can obtain the following first-order-approximation:

$$- \left[D_t - \frac{P_{t-1}}{P_t} D_{t-1} \right] \approx - \left[\hat{D} + \hat{P} \right] D_{t-1} \quad (39)$$

In this way both D and P may be interpreted as implicit tax rates levied on the last-period stock of real money balances; the above expression represent budget finance by seigniorage.

The government's net debt (U) is the gross debt held by the domestic private sector less the government's holding of foreign assets. Real private wealth is then (21) the sum of the capital stock valued at real stock exchange prices, the net national debt and the nation's external assets. The real demand for currency (22) is taken as depending on wealth, output and the nominal interest rate.

The Rate of Profit

Finally the model is completed by an equation (23) for the rate of return on fixed capital. Gross profits are obtained from total revenue $G_t = G_t P_t$, by subtracting imported input costs ($P^M M/E$) and labour costs $(1 + S)WL$ gross of the payroll tax payments. After allowing for depreciation of capital ($\psi_2 K_{t-1}$) at replacement cost (P_t) we then determine the net rate of return (Z) relative to the capital stock at market prices in the previous period. Thus, equation (23) is consistent with the accounting framework for factor costs of production described earlier. The rate of return is linked to the rate of interest by an arbitrage equation (24) for the valuation ratio.

2.4 Parameter Values

We now present the parameter values used in the simulation of our model.

Table 2.3

Parameter Values

$$\begin{aligned}
 \alpha_1 &= 0.850, & \alpha_2 &= 26/\bar{Y} = 0.0253 \\
 \beta_0 &= 0.20, & \beta_1 &= 18 & \beta_2 &= 0.20, & \beta_3 &= 0.50 \\
 \gamma_0 &= 0.44217, & \gamma_1 &= 0.7425, & \gamma_2 &= 0.3575 & \gamma_0' &= 0.276 \\
 \delta_1 &= 9/\bar{V} = 0.0087 & \delta_2 &= 20/\bar{Y} = 0.2, & \delta_3 &= 4/\bar{R} = 0.5 \\
 \epsilon &= 0.26\bar{N} = 260 \\
 \lambda_1 &= 0.7, & \lambda_2 &= 0.65, & \lambda_3 &= 0.02, & \lambda_4 &= 0.50, & \lambda_5 &= 0.80 \\
 \xi_1 &= 0.10, & \xi_2 &= 1.0, & \xi_3 &= 0.3, \\
 \phi_1 &= 0, & \phi_2 &= 1.5 \\
 \psi_1 &= 0.15, & \psi_2 &= 0.006
 \end{aligned}$$

The values for γ_1 and γ_2 ensure that there are modestly increasing returns to scale; the effect of this is investigated in our subsequent simulations. Combined with an annual rate of interest of 8%, these values give a ratio of capital stock to annual output of 2.5.

The value of ϕ_2 corresponds to a value we had estimated for the U.K. in such an equation. It does however, result in capital being rather immobile, and in future use of this model we consider there to be a strong case for experimenting with a higher value.

3. The Steady State

The full properties of a model of this type have to be investigated by means of dynamic simulation; an analytic solution is not possible. However a useful insight into the policy options available in an economy such as this can be given by a steady-state solution. This can be calculated analytically as shown in table 3.1. Time subscripts are eliminated to give:

Table 3.1

The Steady State Solution

$$C^P = \alpha_1 \rho L + \alpha_2 V \quad (1)'$$

$$X = (\beta_0 Y^F - \beta_1) + \beta_1 \tau \quad (2)'$$

$$M = \beta_2 Y \quad (3)'$$

$$L_4 = \gamma_0' YK \quad -\gamma_2 \quad (\gamma_1 + \gamma_2 - 1) \quad (4)'$$

$$T = \frac{P^X}{P} (X - \mu \tau M) \quad (5)'$$

$$Q = 1 \quad (6)'$$

$$K = \frac{\gamma_2 G}{(\gamma_1 + \gamma_2)(R + \psi_2)} \quad (7)'$$

$$I = \psi_2 K \quad (8)'$$

$$Y = C^P + C^G + I + X \quad (9)'$$

$$W = \rho P \quad (10a)'$$

$$\rho = (L/L_0)^{\xi} \rho_0 \quad (10b)'$$

$$1 = \left[1 + \frac{\epsilon}{N} \right] \left[(1 + S)\rho \frac{L}{Y} + \beta_2 \mu \tau \right] \quad (11)'$$

$$\frac{P^X}{P} = \beta_3 + (1 - \beta_3) \frac{P^X}{P} \tau = \frac{\beta_3}{1 - (1 - \beta_3)\tau} \quad (12)'$$

$$G = C^P + C^G + I + \frac{P^X}{P} (X - \mu \tau M) \quad (13)'$$

$$J = T + R^F H \quad (14)'$$

$$J = 0 \quad (15)'$$

$$H = H^P + H^G \quad (16)'$$

$$H^P = \{\phi_1 - \phi_2(R - R^F)\}V \quad (17)'$$

$$F = 0 \quad (18)'$$

$$S\rho L = C^G + RA - R^F H^G \quad (19)'$$

$$U = A + D - H^G \quad (20)'$$

$$V = H + U + QK \quad (21)'$$

$$D = \delta_1 V + \delta_2 Y - \delta_3 R \quad (22)'$$

$$Z = \frac{G - (1+S)\rho L - \psi_2 K}{QK} \quad (23)'$$

$$R = Z \quad (24)'$$

In the above expressions ρ gives the real wage rate (W/P). Equation (10b)', which links this to the level of employment is derived by integrating equation (10) and introducing L_0 as the constant of integration. τ represents competitiveness P^F/EP^X , i.e. the inverse of the real exchange rate. μ is the ratio P^M/P^F , i.e. of the price of imported inputs to that of finished foreign goods. This exogenous ratio, μ , is useful in order to distinguish various types of shocks, and in particular to distinguish the effect of an increase in the price of imported inputs from that of a general rise in foreign prices.

Equation (1)' to (24)' can be helpfully rearranged into three groups as follows: In the first group with barred values are variables whose steady-state values do not explicitly involve the policy variables (R, S, E). They are end-period constraints on some flow variables (B, J, F), express ratios to output that are constant in the long run, and give the equilibrium value for Tobin's Q . The second group consists of eleven equations that can be solved to determine the eleven variables $G, K, L, Y, N, H^G, H^P, A, V, \tau$ and ρ in terms of the two policy instruments (R, S), the exogenous variables (R^F, Y^F, C^G) and the model parameters. The third group can

then be used to "look up" the values of the remaining variables in terms of the policy instruments (R, S) and the variables of the second group.

Table 3.2 **The Steady State in Three Groups**

Group I: Flow Constraints and Constant Ratios

Derived from
Equation:-

$$(15) \quad J = 0 \quad (I.1)$$

$$(18) \quad F = 0 \quad (I.2)$$

$$(19) \quad B = 0 \quad (I.3)$$

$$(6) \quad Q = 1 \quad (I.4)$$

$$(3) \quad M = \beta_2 Y \quad (I.5)$$

$$(8) \quad I = \psi_2 K \quad (I.6)$$

Group II: Other Behavioural Relationships

Derived from

$$(2)', (3)', (12)', (14)', (15)' \quad \beta_0 Y^F + \beta_1 (\tau-1) - \mu \beta_2 \tau Y = -R^F H \frac{1 - (1-\beta_3)\tau}{\beta_3} \quad (II.1)$$

$$(31) \quad K = \frac{\gamma_2}{\gamma_1 + \gamma_2} \frac{G}{R + \psi_2} \quad (II.2)$$

$$(30) \quad L = \frac{\gamma_1}{\gamma_1 + \gamma_2} \frac{G}{\rho(1+S)} \quad (II.3)$$

$$(2)', (3)', (13)' \quad G = (1-\mu\beta_2\tau)Y + \frac{(1-\beta_3)(\tau-1)}{1 - (1-\beta_3)\tau} (\beta_0 Y^F - \beta_1 + \beta_1 \tau) \quad (II.4)$$

$$(19)' \quad A = \frac{S\rho L - C^G + R^F H^G}{R} \quad (II.5)$$

$$(21)', (22)' \quad (1-\delta_1)V = A + H^G - H + \delta_2 Y - \delta_3 R + K \quad (II.6)$$

$$(1)', (9)', (14)' \quad \alpha_1 \rho SL + \alpha_2 V + \psi_2 K + C^G = G + R^F H \quad (II.7)$$

$$(11)', (30)' \quad 1 = \left[1 + \frac{\epsilon}{N} \right] \left[\frac{\gamma_1}{\gamma_1 + \gamma_2} \frac{G}{Y} + \mu\beta_2 \tau \right] \quad (II.8)$$

$$(16)', (17)', \quad \frac{H - H^G}{V} = \phi_1 - \phi_2 (R - R^F) \quad (II.9)$$

$$(4)', (30) \quad (1+S) \gamma_1 = \gamma_1' \frac{N}{0} \frac{-(\gamma_1 + \gamma_2 - 1) \gamma_1 + \gamma_2}{G} \frac{\gamma_1 + \gamma_2}{(R + \psi_2) \rho^2 \gamma_1 Y} \quad (II.10)$$

where

$$\gamma_0' = \frac{\gamma_0 \gamma_1 \gamma_2}{(1 - \beta_2)(\gamma_1 + \gamma_2)} \frac{\gamma_1 \gamma_2}{\gamma_1 + \gamma_2} = 0.2762$$

$$(10b)' \quad \rho = \rho_0 (L/L_0)^{\xi_1} \quad (II.11)$$

Group III: Post-equations

Derived from

$$P = \frac{P^F}{E \tau} \quad (III.1)$$

$$(10a)' \quad W = \rho P \quad (III.2)$$

$$(12)' \quad P^X = \frac{\beta_3 P}{1 - (1 - \beta_3)\tau} \quad (III.3)$$

$$(16)' \quad H^P = H - H^G \quad (III.4)$$

$$(14)', (15)' \quad T = -R^F H \quad (III.5)$$

$$(2)' \quad X = \beta_0 Y^F + \beta_1 (\tau - 1) \quad (III.6)$$

$$(1)' \quad C^P = \alpha_1 \rho L + \alpha_2 V \quad (III.7)$$

$$(22)' \quad D = \delta_1 V + \delta_2 Y - \delta_3 R \quad (III.8)$$

$$(16)', (20)' \quad U = A - H^G + \delta_1 V + \delta_2 Y - \delta_3 R \quad (III.9)$$

$$(24)' \quad Z = R \quad (III.10)$$

Let us first briefly comment on Group I. Equation (I.1) ensures long-run stabilisation of total foreign assets (H) so that the external positions of the country is sustainable. Equation (I.2) implies a steady-state for official exchange reserves (H^G), and this in turn leads to a stable level of private foreign assets (H^P). In (I.3) zero long-run deficits guarantee that domestic debt of the government is finite. With output and capital stock stabilised in the goods market, it follows that all individual components of private sector wealth (V) are stable.

Equation (I.4) rules out a permanent discrepancy between the market value and the replacement cost of capital goods. It also ensures that the number of firms stops changing in the long run. The last two equations (I.5) and (I.6) give imports and steady-state investment as fixed proportions of gross output and capital stock respectively.

In Group II there are eleven equations with nine endogenous variables (ρ , τ , Y , G , K , L , A , V and N), five exogenous variables (Y^f , P^M , P^f , R^f and C^G) and four policy variables (H , H^G , R , S). If the authorities fix the interest rate, R and the tax rate S exogenously, the stock variables (H , H^G) become endogenous and together with the other eight unknowns can be determined by the equations available. It should be noted that these variables are defined in real terms. This real solution is homogeneous of degree zero in P . But equation (III.1) means that, for given values of τ and P^f the selection of a particular nominal exchange rate defines the price level, or *vice versa*.

In this paper however, we choose to specify a policy framework in which the authorities use fiscal and monetary policy in order to achieve predetermined targets for total national assets (H^*) held abroad, and foreign exchange reserves (H^G). During dynamic adjustment the policy authorities aim to keep the nominal exchange rate close to a specified target, with the consequence that the steady-state price level is also determined.

Independently of this nominal exchange rate target, and assuming that in the long run the other two targets are actually achieved⁷, so that $H = H^*$ and $H^G = H^G$, the system of

⁷ There is no loss of generality in assuming asymptotic attainment of targets, because they can be achieved by appropriate policy rules. This remains true if the target values are chosen in the light of a welfare function which also reflects the instrument settings.

equations in Group II can be now used to determine the asymptotic values to which the policy instruments, R and S , should be set. The particular structure of rules by which these targets are reached is described in section 4.1.

The policy framework is completed by specifying the way in which the exchange rate (E) is determined. Following the discussion in Section 2, we adopt a nominal exchange rate target (E^*) to which actual rate (E) is kept close by means of intervention (F). In the steady-state the target is achieved ($E=E^*$) and intervention ceases ($F=0$). As noted above, this then determines the steady-state price level.

The above policies operate in an economy in which real wages respond only to unemployment, so that nominal exchange targets will come under severe stress, when adverse demand and supply shocks are considered.

Having specified the policy regime, we move now to discuss the equations of Group-II, and the way in which key variables are determined.

3.2 *Determination of Competitiveness and Output*

Equation (II.1) is derived by substituting trade flows, the ratio P^x/P and foreign interest payments in (14') and 15'). For a given target, H^* , this equation implies the value of competitiveness (τ) and the level of gross output which are consistent with zero steady-state balance of payments. Solving for output we obtain

$$Y = \frac{\beta_0 Y^F - \beta_1 + R^F H / \beta_3}{\mu \beta_2 \tau} + \frac{\beta_1 - (1 - \beta_3) R^F H / \beta_3}{\mu \beta_2} \quad (40)$$

This may be interpreted as the external constraint on output.

Its locus is shown by the downwards sloping curve (jj) in Figure 1. With a fall in world demand, Y^F , it shifts leftwards to $j'j'$, so that, at the same level of competitiveness, lower output is required in order to reduce imports and bring the trade deficit to offset the unchanged property income flow ($R^F H^*$).

In order to avoid the fall in output the authorities could raise the long-run foreign wealth target (H^*) so that increased interest payments compensate for trade losses and current balance is restored. This can be done, for example, by a real appreciation of the currency that attracts foreign capital, though at the cost of deteriorating competitiveness (point τ_2).

A supply shock that for example rises import prices (P^M) but not those of foreign

finished goods may be seen as a rise in the ratio $\mu = P^M/P^F$. Locus jj moves again leftwards, but now it also becomes flatter because the slope, $\partial Y/\partial \tau$, decreases in absolute terms.

The other relationships between output and competitiveness may be obtained by substituting K, L, A and V from (II.2) to (II.6) into equations (II.7) and reformulating it as another (Y, τ) locus. Of those equations, (II.6) is the definitional identity of wealth, (II.4) is the definition of real income, (II.2) and II.3) are derived from the optimising behaviour of producers according to Section 2, and (II.7) gives the equality between total supply and demand.

The remaining equation (II.5) gives the stock of interest-bearing debt (A) which is compatible with the budget constraint equations (18)' and (I.3). This stock affects private wealth, private consumption and, thus, output which in turn is the determinant of employment, taxation and finally of the steady-state debt. Hence, in figure 2, the (bb) locus, derived from (II.2) to II.7) may be seen as giving the levels of output and competitiveness which are compatible with the government budget constraint, and the production decisions by the firms.

To avoid unduly complicated expressions we can simplify the equations by assuming that the country is a price-setter, so that $\beta_3=1$ and the second term in the right-hand side of (II.4) vanishes. By setting $\delta_0 = 1/(1-\delta_1)$, we obtain after rearranging (II.7)

$$Y = \frac{(\alpha_2 \delta_0 - R^F) H + \alpha_2 \delta_0 (R^F/R-1) H^G - (\alpha_2 S \delta_0 \delta_3) R + (1 - \alpha_2 \delta_0/R) C^G}{(1 - \beta_2 \mu \tau) (1-\Gamma) - \alpha_2 \delta_2 \delta_0} \quad (41)$$

where

$$\Gamma = \frac{1}{\gamma_1 + \gamma_2} \left[\gamma_1 \frac{\alpha_1 + \alpha_2 \delta_0 S/R}{1 + S} + \gamma_2 \frac{\alpha_2 \delta_0 + \psi_2}{R + \psi_2} \right] \quad (42)$$

This expression does not show directly the effect of labour supply (or the real wage) on the level of output. However equation (II.10) makes clear the link between the real wage and the

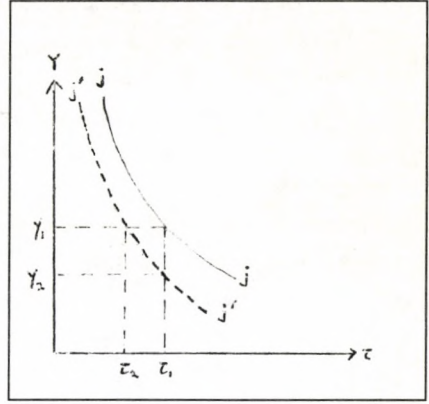


Figure 1 The External Constraint: Competitiveness and Output

tax rate through the production function, and this represents the link to output. Our diagrammatic analysis takes the tax rate, S , as parametric and thereby implicitly considers a situation in which a relatively elastic labour supply keeps the real wage relatively constant.

The numerator in (41) as well as expressions Γ in (42) depend only on the target (H, H^c) and instrument (R, S) variables and the exogenous level of public spending. For $\Gamma < 1$, i.e. for propensities to consume (α_1, α_2) not excessively high, and with δ_0 not too high (δ_1 small), the locus (aa) is upwards sloping in τ as can be seen in Figure 2. Any change which leads to higher taxation moves the locus rightward to ($b'b'$).

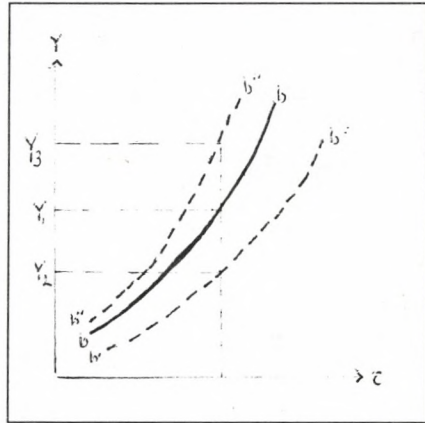


Figure 2 The Production Constraint Output and Competitiveness

A reduction in world demand (Y^f falls) may be analyzed indirectly through the effect on taxation: with exports falling, the foreign asset position will remain unchanged only when taxes rise to cut demand and associated imports. Expression Γ falls (as $\partial\Gamma/\partial S < 0$ for reasonable parameter values) and this leads to lower output values for each level of competitiveness. The shift from an asymmetric supply shock which raises import prices (P^M) and ratio μ is somewhat ambiguous. As ratio μ rises, corresponding values for output rise and this tends to shift the locus (bb) upwards to ($b''b''$). However this is mitigated by the rise in taxes which reduces expression Γ and pushes the locus rightwards.

Combining figures 1 and 2 we can now study the combined effects that shocks have on output and competitiveness.⁸ Neither of these show the multiple solutions identified by Pagano (1990). The reason for this is that we have assumed that the labour supply responds elastically to the real wage, and that the labour supply schedule therefore intersects the labour demand schedule only once.

When world demand (Y^f) falls both loci shift downwards and gross output is adjusted

⁸ The assumption that there is a rising labour supply curve does not seem to change the nature of this adjustment. Alogoskoufis (1990) describes a similar process for an economy with a single natural rate of unemployment.

to a lower level (Figure 3.) Competitiveness falls but not substantially (point B), due to the fact that prices are only revised upwards slightly as production becomes less competitive (mark-ups rise).

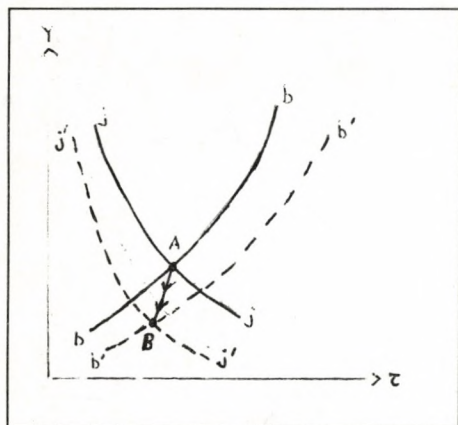


Figure 3 Adjustment after a Shock to Foreign Demand

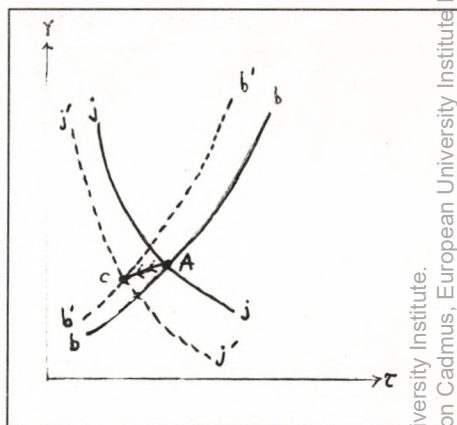


Figure 4 Adjustment after a Shock to Raw Materials' Prices

The situation is different with a rise in raw materials' prices, P^M . Prices rise and nominal wages follow because wages are defined in real terms. Competitiveness deteriorates markedly and the economy is now stabilised at point C in Figure 4. Output is lower and the terms of trade, measured against the world price of finished goods (P^F) are more favourable. This favourable adjustment of the terms of trade is achieved by an increase in the output price as the response to the increase in the raw materials' price, P^M , and has as its corollary the worsening in competitiveness. Both of these effects are in agreement with the results obtained in the full-scale simulation of the model in Section 4.

3.3 Economies of Scale

The importance of economies of scale can be investigated by studying the effect of a change in $\gamma_1 + \gamma_2$ on the two loci which determine τ and Y . It can be seen that the external constraint is independent of $\gamma_1 + \gamma_2$. However the locus bb in figure 2 is affected through expression Γ in (41) and (42). Differentiating with respect to $\gamma_1 + \gamma_2$ we obtain:

$$\frac{\partial \Gamma}{\partial (\gamma_1 + \gamma_2)} = \frac{\gamma_2 - \gamma_1}{(\gamma_1 + \gamma_2)^2} \left[\frac{\sigma_1}{1 + S} - \frac{\sigma_2}{R + \psi_2} \right] \quad (43)$$

where, for brevity, $\sigma_1 = \alpha_1 + \alpha_2 \delta_0 S/R$, $\sigma_2 = \psi_2 + \alpha_2 \delta_0$

In normal circumstances, the coefficient on labour, γ_1 is larger than that on capital, γ_2 . It is also a normal property of the consumption function that $\alpha_2 > R$ (Blanchard, 1985), and indeed if this condition is not met, then property income will tend to accumulate faster than it is spent, creating an unstable feedback. $\delta_0 > 1$, but, if, as is in practice the case, only a small amount of wealth is held as cash, it will be only slightly above 1. Unless the propensity to consume out of labour income, α_1 is close to 1, we may conclude that $\sigma_1/(1+S) < 1$, while there is little reason to doubt that $\sigma_2/(R + \psi_2) > 1$. In normal circumstances, therefore $\partial \Gamma / \partial \gamma > 0$, so that increasing returns to scale (higher γ) shift the locus (*bb*) to the left and the economy is brought to a new steady-state with higher output. This happens because the demand for labour falls relatively little (see 30) and is substituted by capital with higher returns.

3.4 The number of firms and other variables

With variables G , Y and V determined by the first seven equations of Group II, equations (II.8), (II.9) and (II.10) can now be used to find the steady-state values for the number of firms (N), and the policy variables S and R .

Keeping the same simplification as before that $\beta_3 = 1$ and substituting G from (II.4) into (II.8) we obtain after some manipulation that the number of firms is given by the expression:

$$\frac{\epsilon}{N} = \frac{\gamma_1 + \gamma_2}{\gamma_1 + \gamma_2 \beta_2 \mu \tau} - 1 \quad (44)$$

The number of firms rises when competitiveness increases as this raises output and profits. To find the effect that increasing returns have on the number of firms, we rewrite (44) as:

$$\frac{N}{\epsilon} = \frac{\gamma_1}{\gamma_2 (1 - \beta_2 \mu \tau)} + \frac{\beta_2 \mu \tau}{1 - \beta_2 \mu \tau} \quad (45)$$

from which $\partial N / \partial \gamma_1 > 0$ and $\partial N / \partial \gamma_2 < 0$.

A rising productivity of labour encourages new firms to enter production because this raises the input factor of labour relative to capital stock. Higher employment increases demand, and

profits rise both because of higher output revenue and lower depreciation costs.

4. Simulation Properties of the Model

The dynamic properties of the model may be demonstrated by simulating different types of demand and supply shocks under the assumption of prespecified targets for the nominal exchange rate, total foreign wealth and foreign reserves. Without loss of generality we consider that these targets are set equal to their equilibrium levels before the shock. As the shocks impinge upon the economy, the authorities use fiscal and monetary policy, as well as foreign exchange intervention to achieve asymptotically desired levels for the target variables. We aim to find out how the overall outcome is sensitive to the presence of increasing returns to scale, as a way of indicating the practical importance of scale effects on the response of the economy to these shocks.

4.1 Policy Rules

Our policy rules could have been chosen on the basis of an explicit welfare function, the definition of which reflects the relative preoccupation of the government to achieve some targets more effectively than others. However, the merits of an optimisation exercise in a theoretical model are limited as results will be strongly influenced by the specification of preferences. We have chosen to investigate the situation prevailing in a fixed exchange rate situation, and this, in itself effectively pins down one of the policy instruments. Monetary policy (interest rate fixing and foreign exchange intervention) has to be used to maintain the nominal exchange rate. In order to avoid stock instability (See Weale *et al*, 1990, Ch. 4) fiscal policy must then be set with reference to some wealth objective. We have taken the wealth target to be net external wealth, H , on the grounds that this reflects a current preoccupation. We have therefore chosen simple monetary policy rules which are effective at keeping the nominal exchange rate near its target and a fiscal policy rule designed to bring net foreign wealth to zero. The following policy rules are found to be satisfactory:

(i) *Fiscal Policy*

$$\Delta S_t = -0.30 \Delta H_{t-1} - 0.02(H_{t-1} - H^*) \quad (46)$$

(ii) *Monetary Policy*

$$\Delta R_t = -0.03 \Delta H_{t-1}^G - 0.005(H_{t-1}^G - H^{G*}) \quad (47)$$

(iii) *Official Intervention*

$$F_t = 0.80 \Delta(H_{t-1}^G - H^{G*}) - 40 \Delta E_t/E_{t-1} - 10(E_{t-1} - E^*)/E^* \quad (48)$$

The above policy structure implies active use of fiscal policy whenever the external position of the country, represented here by total foreign wealth (H), is disturbed. When adverse shocks affect the external account, domestic demand will be cut in order to restrict imports and allow the gradual return of the trade deficit to the initial level. In our model the tax increase needed to reduce demand has the effect of adding to costs. With the nominal exchange rate fixed, this policy aggravates the depressing effect of the tax increase on output, but reduces its effectiveness as a means of dealing with balance of payments disequilibrium. The problem is aggravated further because wages are effectively set in real rather than nominal terms. This enhances the cost-push nature of tax increases and further offsets the effects of the shock on the current account.⁹

4.2 Simulation Results

To illustrate the implications of economies of scale with the aforementioned assignment of targets and instruments, we simulated the model under the assumption of perfect foresight in stock-exchange and capital markets¹⁰. The valuation ratio (Q) is free to react to unanticipated changes but in the long run it returns to its equilibrium level of one. The exchange rate is freely-floating, although its movements are effectively constrained by official intervention (48). In the long run this also returns to the target level, here set equal to the initial steady-state.

The following permanent shocks are considered:

- (a) A shock to foreign demand, represented by a fall in world demand (Y^F) by 5%.
- (b) A supply shock, expressed as an increase in import prices (P^M) by 5%.

Results of some key variables of the model are shown in Tables 4.1 and 4.2 for various time periods. To identify the importance of the returns to scale we also present the values of the same variables when the same shock is applied but production is characterised by constant returns i.e. we set $\gamma_1 = 0.7425$ and $\gamma_2 = 0.3575$ so that $\gamma_1 + \gamma_2 = 1$ rather than 1.1 but γ_1/γ_2 is unchanged.

4.3 A Shock to Foreign Demand

Let us first examine the effects and the policy response to a fall in world trade. Exports

⁹ Of course, if these offsetting effects were strong enough, the policy would not work. But with our parameter values they do no more than impede the working of the policy.

¹⁰ The solution technique was based on full-period iterations, and was similar in approach to that suggested by Fisher *et al.* (1985).

fall immediately and output is reduced initially by about 1%. As the trade deficit starts widening, the current balance deteriorates and total foreign wealth is reduced. The rise in payroll taxation pushes prices up; wages follow in order to keep real wages constant and as a consequence demand for labour and output will fall even further in the short run. Because private agents foresee future reductions in profits, the valuation ratio falls immediately by 1.50% and this causes a reduction in investment because, in the face of lower demand, some firms withdraw from the market. Investment only recovers somewhat as the valuation ratio starts to rise back towards its equilibrium value. Production recovers from the worst of the depression and by the end of the solution period output and employment have reached a level which is around 5% below the initial steady-state. The nominal exchange rate is kept close to its target value; H and H^c are also kept reasonably close to their desired values.

From Table 4.1, one can see that the results are essentially the same with constant returns, confirming the observations made in section 3. It is only employment which will now be further reduced to 5.40% below the initial steady-state instead of 4.9% under increasing returns. Since both γ_1 and γ_2 have been reduced in equal proportions, the percentage change in output is the similar in each case in the long run. Equation (30) then suggests that the lower level of employment in the second case should be attributed to higher taxes. The simulation results confirm this view. In fact the tax rate rises markedly in the short run but later oscillates around modest levels above the base values. Prices change little, and this keeps competitiveness very close to the steady-state level (table 4.2).

4.4 A Shock to Import Prices

A similar recession is observed when the price of imports rises. The channel, though, is different because the primary effect now is the immediate rise of production cost that prices domestic producers out of foreign markets when we assume that the price of the foreign producers (P^f) is not affected. Exports fall and the deteriorating trade deficit triggers a fiscal restraint as strong as in the previous case. At the end of the simulation period output and employment fall by over 4%, and this figure is again larger for employment under constant returns to scale. In this case prices rise more substantially (over 4%) and, as noted in section 3.2, this causes a more serious deterioration in competitiveness.

What is remarkable in both simulations is the strong recession that is observed. This is a consequence of the slightly rising labour supply curve, which means that any situation which requires a lower real wage must be associated with a permanent reduction in output. Although the magnitude of the above phenomena should only be taken as indicative because of the qualitative nature of several equations in the model, the policy implications are in line with the

conclusions elaborated by Bruno and Sachs (1985, Ch.7) in a simulation model.

Table 4.1 A Fall in Foreign Demand (Y^*) by 5%

Period			1	9	16	75
Output	Y	a	-1.07	-6.98	-5.37	-4.98
		b	-1.10	-6.50	-5.09	-4.94
Gross Dom. Product	G	a	-1.05	-6.43	-5.24	-4.83
		b	-1.10	-6.24	-5.16	-4.86
Capital	K	a	0.0	-0.71	-1.32	-3.35
		b	0.0	-0.73	-1.32	-3.49
Employment	L	a	-1.11	-8.82	-6.34	-4.92
		b	-1.27	-9.03	-6.59	-5.43
Prices	P	a	-0.04	4.69	1.02	1.19
		b	-0.07	2.10	-0.55	0.62
Wages	W	a	0.0	5.09	0.58	0.73
		b	0.0	2.75	-1.25	0.06
Valuation ratio	Q	a	-1.5	-5.36	-1.28	-0.04
		b	-1.87	-3.70	-0.16	-0.02
Interest rate	R	a	0.0	0.60	0.54	-0.29
		b	0.0	0.48	0.46	-0.17
Tax rate	S	a	0.0	9.08	6.39	1.80
		b	0.0	6.22	7.61	3.88
Exchange rate	E	a	0.20	0.34	0.15	0.0
		b	0.10	0.20	0.07	0.0
Total foreign Assets	H	a	-0.49	0.35	0.08	0.04
		b	-0.49	0.31	-0.04	0.02
Foreign Exchange Reserves	H^G	a	0.10	0.08	0.06	-0.01
		b	0.05	0.03	0.01	0.0

Note: All figures show percentage deviations from the steady state, except that, for H and H^G , deviations are measured as a percentage of base period GDP. a shows the result with increasing returns to scale ($\gamma_1 + \gamma_2 = 1.1$) and b the result with constant returns to scale ($\gamma_1 + \gamma_2 = 1$).

Table 4.2

A Rise in Import Prices (P^M) by 5%

Period			1	9	16	75
Output	Y	a	-0.39	-6.55	-5.12	-4.51
		b	-0.40	-6.25	-4.98	-4.53
Gross Dom. Product	G	a	-1.55	-6.49	-5.63	-5.23
		b	-1.53	-6.47	-5.57	-5.16
Capital	K	a	0.0	-0.83	-1.51	-3.71
		b	0.0	-0.86	-1.52	-3.84
Employment	L	a	-0.38	-8.40	-6.04	-4.18
		b	-0.44	-8.87	-6.46	-4.70
Prices	P	a	0.66	10.52	6.03	4.40
		b	0.65	7.71	4.35	3.94
Wages	W	a	0.0	11.12	5.83	3.97
		b	0.0	8.69	3.74	3.46
Valuation ratio	Q	a	0.32	-7.26	-2.90	-0.04
		b	-0.42	-6.09	-1.99	-0.04
Interest rate	R	a	0.0	0.63	0.48	-0.30
		b	0.0	0.60	0.49	-0.27
Tax rate	S	a	0.0	10.18	5.52	-1.71
		b	0.0	6.66	7.74	0.04
Exchange rate	E	a	0.19	0.39	0.17	0.0
		b	0.14	0.30	0.13	0.0
Total foreign Assets	H	a	-0.89	0.44	0.21	0.04
		b	-0.89	0.44	0.08	0.04
Foreign Exchange Reserves	H^G	a	0.10	0.12	0.09	-0.02
		b	0.07	0.08	0.06	-0.01

Note: All figures show percentage deviations from the steady state, except that, for H and H^G , deviations are measured as a percentage of base period GDP. a shows the result with increasing returns to scale ($\gamma_1 + \gamma_2 = 1.1$) and b the result with constant returns to scale ($\gamma_1 + \gamma_2 = 1$).

5. Conclusions

The use of a simulation framework allows the construction of a model in which no important feedback has been neglected. Our model has, in particular, provided a novel modelling of the mark-up based on a simple structure of imperfect competition. However the simulation model should be developed in a number of ways.

First, the introduction of a consumption function such as that described by Blanchard (1985) would allow the study of forward-looking consumption behaviour. Secondly, the extension of the model to a multi-country framework would allow a detailed study of the effects of policy co-operation. In particular it would allow investigation of whether the greater gains arise from co-operation between similar countries or countries which differ in important factors such as labour market structure, and in the economies of scale.

However, our most important, and perhaps rather surprising conclusion is that our policy structure appears extremely robust to the variation in supply conditions represented by the degree of economies of scale. This leads us to infer that, while the presence of economies of scale may have a major impact on the desirability of some types of policy changes, it does not affect very much the working of a simple stabilization policy in the presence of a fixed nominal exchange rate.

6. References

- Alogoskoufis, G. (1990). "Traded Goods, Competitiveness and Aggregate Fluctuations in the United Kingdom". *Economic Journal* Vol. 100. pp. 141-63.
- Blanchard O.J. (1985). "Debt, Deficits and Finite Horizons". *Journal of Political Economy* Vol. 93. pp. 224-247.
- Blinder A. and R. Solow. (1973). "Does Fiscal Policy Matter". *Journal of Public Economics*. Vol. 2. pp. 319-37.
- Bruno, M. and J. Sachs. (1985). *Economics of Worldwide Stagflation*. Harvard University Press.
- Budd, A., P. Levine and P. Smith. (1988). 'Unemployment, Vacancies and the Long-term Unemployed'. *Economic Journal*. Vol. 98. pp. 1071-91.
- Easton W.W. (1985). "The Importance of Interest Rates in Five Macroeconomic Models". Bank of England Discussion Paper No. 24.
- Fisher P.G., S. Holly and A.J. Hughes-Hallet (1985). "Efficient Solution Techniques for Dynamic Non-Linear Rational Expectations Models". London Business School Discussion Paper no. 142.
- Hart, O. (1982). "A Model of Imperfect Competition with Keynesian Features". *Quarterly Journal of Economics*. Vol. 97. pp. 109-38.
- Lawson, T. (1982). 'On the Stability of the Inter-industry Structure of Earnings in the United Kingdom'. *Cambridge Journal of Economics*. Vol. 6. pp. 249-66.

- Layard, R. and S. Nickell. (1985). "The Causes of British Unemployment". *National Institute Economic Review*. Vol. pp. 62-86.
- Meade J.E. (1986). *Alternative Systems of Business Organisation and Workers' Remuneration* Allen and Unwin.
- Pagano, M. (1990). "Imperfect Competition, Underemployment Equilibria and Fiscal Policy". *Economic Journal*. Vol. 100. pp. 440-63.
- Sargent T.J. and N. Wallace, (1981), "Some Unpleasant Monetarist Arithmetic" *Federal Reserve Bank of Minneapolis Quarterly Review* Vol. 5. pp. 1-17.
- Weale M., A. Blake, N. Christodoulakis, J.E. Meade and D.A. Vines, (1989), *Macroeconomic Policy: Inflation, Wealth and the Exchange Rate*, Unwin and Hyman, London.
- Weitzman, M. (1982). "Increasing Returns and the Foundations of Unemployment Theory". *Economic Journal*. Vol. 92. pp. 787-804.
- Westaway P., and Whittaker R., (1986). "Consistent Expectations in the HMT model", H.M. Treasury Working Paper No. 86, March.
- Whittaker R., Wren-Lewis S., Blackburn K. and Currie D., (1986), "Alternative Financial Policy Rules in an Open Economy under Rational and Adaptive Expectations", *Economic Journal*, Vol. 96. pp. 680-695.



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