A SYSTEMS APPROACH TO THE DEMAND FOR IMPORTS AND DOMESTIC OUTPUT IN THE UK†

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This paper is concerned with the allocation of total final expenditure between different categories of domestic output in the UK and imported goods. It is argued that the full complexity of these relationships can only be properly captured within the framework of a demand system with the simultaneous estimation of a disaggregated model. The paper explains the theoretical relationship between the underlying structural model and the chosen specification which relates final expenditure to net output and total imports, and reports econometric estimates obtained from UK data for the period from the late 1960s to the present day.

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I. Introduction

This paper is concerned with the allocation of total final expenditure between different categories of domestic output in the UK and imported goods. This problem may be viewed as an example of a standard demand system with consumers allocating a given budget, total final expenditure, over a number of different goods, here represented by the output of the different domestic and overseas producers.

The approaches taken to this issue by different macroeconomic modellers have fallen into one of two main categories. The expenditure driven approach adopted by the Treasury and the National Institute (see Melliss *et al.*, 1989 and NIESR, 1991) derives separate equations for the main components of total domestic expenditure plus imports and exports, with total output being obtained from the national income identity that output equals expenditure. An alternative approach utilised by the London Business School (Dinenis *et al.*,1988) determines output from the supply side with imports being treated as a residual to satisfy the national income identity.. In this paper, following Anderton *et al.* (1989), we argue that the question of whether imports or output (or indeed anything else) is the residual category is the wrong question to be asking since both will be determined simultaneously by the decisions of consumers and producers.

Within the conventional framework described above, various degrees of sophistication have been adopted in estimating the sectoral or commodity disaggregation of imports and domestic output. Most macromodels exploit the observation evident from input-output tables that different components of final expenditure generate very different demands for a particular commodity. Indeed some models (see Melliss *et al.*,1989) simply impose coefficients taken directly from either input-output tables or commodity flow accounts in their sectoral output equations. Other models such as that of the National Institute explain output categories through a matrix of estimated coefficients related to expenditure components.

In a similar fashion, both Gleed (1985) and Anderton and Desai (1988) have estimated import volume specifications allowing different expenditure components to embody different import intensities. These latter import studies adopt a log-linear single equation estimation framework which assumes that expenditures on domestic and foreign goods can be specified independently of each other. This assumption is criticised in Anderton *et al.* (1989) as the usual specification of a log-linear model of import demand implies a different, non-linear functional form for the demand for domestic output. Anderton *et al.* (1989) seek to overcome this problem by adopting a functional form based on the Almost Ideal Demand System (AIDS), thereby imposing an identical functional form for both output and imports of manufactures.

However, an AIDS specification for manufactured goods only provides a partial solution to the range of problems caused by the adding-up constraints, simultaneity and interdependence of different commodities. This paper suggests that the full complexity of these relationships can only be captured through the simultaneous estimation of a disaggregated model of all categories of domestic output and imports. Such a model will ensure both that imports and domestic output sum to total final expenditure and that the complex inter-linkages between individual commodities, in terms of intermediate and final demand as well as the choice between foreign and domestically supplied products, are captured.

The plan of the rest of the paper is as follows. Section II sets down the theoretical relationship between total final expenditure, output and imports. It is shown how the underlying structural demand system involves an allocation of TFE between final domestic output and final imports, with intermediate imports and net output being determined by the production technology. Because of the data problems inherent in obtaining both output for final demand and intermediate inputs into production, we illustrate how the underlying system can be expressed as a "reduced form" model relating final expenditure to net output and total imports. Section III explains how this alternative system can be estimated using a dynamic model related to the one used in Anderson and Blundell (1982, 1983). Section IV gives the main econometric results and Section V presents some illustrative simulations using the current NIESR model and our preliminary results. Section VI concludes and suggests how this work might usefully be extended.

II. Theory of imports, output and expenditure

In this section we use a simple stylised model to illustrate the theoretical relationship between total final expenditure, domestic output and imports (both intermediate and final). First, we illustrate that the underlying theoretical model comprises two distinct parts; the underlying demand system which allocates total final expenditure (TFE) between final domestic output and final imports and, second, the model describing the production technology which relates the use of intermediate inputs, domestically produced and imported, to final output.

Consider a simple open economy model with one domestic production sector. Final demand will be equal to total domestic expenditure at factor cost (TDE) plus total exports (X). This demand will be met by either domestic producers (D_F) or by importers (M_F). If the proportion met by domestic producers is α, then we can write:

$$D_F = \alpha(TDE + X) \qquad [1a]$$

and

$$M_F = (1-\alpha)(TDE + X) \qquad [1b]$$

From [1a] and [1b] it would appear as if both components of expenditure should have identical coefficients. However the implications of export demand and domestic demand are quite different. Domestic demand, comprising consumption, investment, government spending etc. represents an ex ante demand which, ex post, may be met by domestic or overseas producers. In contrast, the export demand equation has already determined the domestic-overseas split. Ex post, we therefore know that this element of final expenditure will be met by domestic producers[1]. Equations [1a]-[1b] now become [1c] and [1d] with different coefficients on exports from the remaining components of final expenditure:

$$D_F = \alpha(TDE) + X \qquad [1c]$$

and

$$M_F = (1-\alpha)(TDE) \qquad [1d]$$

The split of final domestic expenditure between overseas and domestic production will be affected by two main factors;

(i) Relative price terms which will explain why a given agent will switch demand between imports and domestic production. This type of term is typically included in import equations (see Anderton *et al.*(1989) for example) but it is very rarely made explicit in models determining domestic output (see Darby and Wren-Lewis, 1990).

(ii) Terms which reflect the composition of TDE based on the observation that different expenditure categories will display different propensities to leak into imports. Such terms are used in both Gleed (1986) and Anderton and Desai (1988).

Thus far, output for final demand is identical to both net output (or value added) and gross output. This is no longer the case once allowance is made for intermediate inputs into production. If we allow for intermediate imports (MI) the national income identity becomes:

$$TDE + X = (D_F - M_I) + M_F + M_I$$
$$= D_N + M_F + M_I \qquad [2]$$

where D_N denotes the net output of domestic producers. If the proportion of intermediate imported inputs in domestic production is k we can write:

$$D_N = (1-k)D_F = (1-k)\alpha TDE + (1-k)X \qquad [3a]$$

and: $$M = M_F + M_I = (1-\alpha(1-k))TDE + kX \qquad [3b]$$

This illustrates that the original consumer demand system can readily be adapted to one in which final expenditure is allocated between net domestic output and total imports. Once the existence of intermediate inputs is admitted, the advantage of the latter formulation is that it offers a set of equations which can easily be estimated since quarterly data is readily available for both net output and aggregate imports.

Equations [3a] and [3b] become more complicated once allowance is made for the existence of more than one domestic production sector. Consider the case where there are two domestic industries, the first of which not only meets final demand but also supplies intermediate inputs to the second industry. Both use intermediate imports. Assume also that there are two types of imports, MA, consisting of final and intermediate goods and MB used only as a production input for industry 1. Let D_{Ii} denote intermediate inputs supplied by domestic industry i, Mj_{Ii} be intermediate imports used by industry i and X_i be exports by industry i. We then have:

$$D_{N1} = D_{F1} + D_{I1} - MA_{I1} - MB_{I1}$$
$$= D_{F1} + h(D_{F2}) - k_1(D_{F1} + D_{I1}) - k_2(D_{F1} + D_{I1})$$
$$= (1-k_1-k_2)D_{F1} + (1-k_1-k_2)hD_{F2} \qquad [4a]$$

and: $$D_{N2} = D_{F2} - D_{I1} - MA_{I2}$$
$$= D_{F2} - h(D_{F2}) - k_3(D_{F2})$$
$$= (1-h-k_3)D_{F2} \qquad [4b]$$

and: $$MA = MA_F + MA_{I1} + MA_{I2}$$
$$= MA_F + k_1(D_{F1} + D_{I1}) + k_3(D_{F2})$$
$$= MA_F + k_1D_{F1} + (k_1h + k_3)D_{F2} \qquad [4c]$$

and: $$MB = MB_{I1}$$
$$= k_2(D_{F1} + D_{I1})$$
$$= k_2D_{F1} + k_2hD_{F2} \qquad [4d]$$

Even under the relatively simple assumptions made above it is clear that there is a possibility that the factors affecting the demand for industry 2's product will enter both the net output and both the aggregate import equations.

With the underlying demand equations having the form:

$$D_{F1} = \alpha_1 TDE + X_1 \qquad [4e]$$
$$D_{F2} = \alpha_2 TDE + X_2 \qquad [4f]$$
$$M_F = (1-\alpha_1-\alpha_2)TDE \qquad [4g]$$

equations [4a]-[4d] become:

$$D_{N1} = TDE[(1-k_1-k_2)(\alpha_1 + \alpha_2 h)] + X_1(1-k_1-k_2)$$
$$+ X_2(1-k_1-k_2)h \qquad [5a]$$
$$D_{N2} = TDE(1-h-k_3)\alpha_2 + X_2(1-h-k_3) \qquad [5b]$$
$$MA = TDE[(1-\alpha_1-\alpha_2) + \alpha_1 k_1 + \alpha_2(k_3 + k_1 h)] + k_1X_1$$
$$+ X_2(k_3 + k_1h) \qquad [5c]$$
$$MB = TDE(\alpha_1 k_2 + \alpha_2 k_2 h) + k_2X_1 + k_2hX_2 \qquad [5d]$$

A number of features of this re-formulated demand system are worthy of emphasis since it this model that forms the theoretical basis of the empirical work in the rest of the paper; first, the coefficients on the different expenditure categories represent a non-linear combination of effects from both consumer preferences (given by the α parameters in equations [4e]-[4g]) and from the production technology (given by the k_i and h parameters in [4a]-[4d]). This has strong econometric implications. For example, if the share of intermediate inputs from industry 1 used by industry 2 changes (i.e. h changes), then instability will be observed in all four equations in the reformulated demand system.

If sufficient data was available on intermediate inputs, then it would be possible to subtract these from the net output and total imports data so as to return to the underlying final demand model. In practice, data is only available intermittently from input-output tables and then with a long lag. The use of fixed coefficients to proxy the k_i and h parameters can only provide a partial solution since these parameters are themselves functions of relative prices, such as the price of intermediate goods produced by industry 1 relative to the price of intermediate imports[2].

The second notable feature of the reformulated system is that although export demand for good 1 does not appear in the structural demand equation for good 2 (and vice versa), it will appear in all the equations in the re-formulated system because of the knock-on effect of intermediate demands in other industries. Equations [5a]-[5d] imply that the same factors should appear in all four equations (at least at the start of estimation). However this consistency requirement is rarely made explicit in macroeconomic models, although it must implicitly be present if the adding-up constraints given by the national income identity are satisfied. In practice the 'residual' equation will contain the mirror image of any effects not offset elsewhere.

The above equations carry strong implications for models in which variables such as a 'demand for manufactures' are created, with imported manufactures being modelled as a share of this demand plus the relative price of imported and domestic manufactures. Even if separability between manufactures and non-manufactures is a valid assumption in the original consumer demand system, it may no longer be so in the net output system if some manufactured goods are used as intermediate inputs elsewhere in the economy. For example, a fall in the demand for consumer durables may well lower value added in both the manufacturing and retail sectors of the economy. The fact that shocks to one sector of demand can spill over into other sectors suggests the use of a systems approach in modelling net output and imports in order to take into account the likely cross-correlation of errors in the respective equations.

III. The Econometric Model

In estimating a systems model for domestic output and imports we want to use a model that satisfies the adding-up constraints imposed by the national income identity, allows the testing of cross-equation restrictions and preserves linearity in variables. We also require a model that permits investigation of whether there are differential effects from individual components of aggregate demand. One possible approach is to use a basic equation of the form:

$$y_i / \Sigma y_i = s_i^y = \alpha_i + \omega_i \ln(TFE) + \Sigma\, \beta_{ih} \ln(p_h) \qquad [6]$$

Here y_i denotes a particular output category, s_i^y denotes the output share, TFE denotes real total final expenditure at factor cost (= Σy_i) and p_h represents the price of goods produced by the *h*'th industry. Output consists of domestic value added plus total imports. Although equation [6] is clearly related to that used in an AIDS model, there are a number of important differences which emerge in the work below. One is that [6] is specified in terms of constant prices rather than the more conventional use of current prices. This reflects the use of physical quantities of goods produced to estimate output volumes.[3]

It is possible to rewrite [6] in a format permitting the testing of differential expenditure effects by following Anderton and Desai (1988) in taking a Taylor series expansion of ln(TFE) around some fixed points. Letting TFE = Σe_j and $\tilde{e}_j$ denote the fixed points, we have:

$$\ln(\Sigma e_j) = \ln(\Sigma\tilde{e}_j) + \Sigma(\tilde{e}_j / \Sigma\tilde{e}_j)(e_j / \tilde{e}_j - 1)$$

$$\cong \tau_0 + \tau_1 \Sigma \ln(e_j) \quad \text{where } \tau_0 = \ln(\Sigma\tilde{e}_j) - \Sigma(\tilde{e}_j / \Sigma\tilde{e}_j)\ln(\tilde{e}_j)$$

$$\tau_1 = \Sigma(\tilde{e}_j / \Sigma\tilde{e}_j) \qquad [7]$$

Substituting [7] into [6] gives:

$$s_i^y = (\alpha_i + \omega_i \tau_0) + \omega_i \tau_1 \Sigma \ln(e_j) + \sum_h \beta_{ih} \ln(p_h)$$

$$= \phi + \sum_j \gamma_{ij} \ln(e_j) + \sum_h \beta_{ih} \ln(p_h) \qquad [8]$$

It is possible that some categories of expenditure may fluctuate around a zero mean. In total final expenditure there are two such categories, stockbuilding (SB) and the residual error between the output and expenditure estimates of GDP (R). Allowance has to be made for these terms before we can make the expansion in [7]. With *n* categories of expenditure [8] becomes:

$$s_i^y = \phi + \sum_{1}^{n-2} \gamma_{ij}\ln(e_j) + (\sum_{1}^{n-2} e_i)^{-1}(\gamma_{n-1}SB + \gamma_n R) + \sum_h \beta_{ih}\ln(p_h) \quad [9]$$

Our main interest in [9] lies in the price responses, the marginal expenditure propensities and the implied elasticities. Letting s_j^e denote the share of expenditure category *j* in total output and expenditure, the marginal propensities for the logarithmic expenditure terms can be expressed as:

$$(\delta y_i/\delta e_j) = \gamma_{ij}/s_j^e + s_i^y - (\gamma_{n-1}s_{n-1}^{e'} - \gamma_n s_n^{e'})(1 + s_{n-1}^{e'} + s_n^{e'}) \quad [10]$$

where $s_k^{e'} = (e_k \,/\, \sum_{j\neq k} E_j)$ (k=1..m). In terms of equation [9] the ratios $s_{n-1}^{e'}$ and $s_n^{e'}$ are simply the ratios of stockbuilding and the residual error to total final expenditure excluding these two categories. The corresponding expenditure elasticities are calculated as:

$$\frac{\delta y_i}{\delta e_j}\frac{e_j}{y_i} = \frac{\gamma_{ij}}{s_i^y} + s_j^e - \frac{s_j^e}{s_1^y}(\gamma_{n-1}s_{n-1}^{e'} - \gamma_n s_n^{e'})(1 + s_{n-1}^{e'} + s_n^{e'}) \quad [11]$$

The γ_{ij} coefficients provide a test of whether the elasticity of any one output category with respect to any category of expenditure differs significantly from the share of that expenditure category in total expenditure. Aggregating [11] across all categories of output, the overall weighted (by s_i^y) elasticity of category e_j is simply s_j^e.

An additional property that comes from [9] and [11] is that the weighted sum of the combined elasticities across all categories of expenditure must be 1 since the adding up constraints impose $\Sigma\gamma_{ij}=0$ and $\Sigma s_i^e=1$. However it is quite possible for the overall expenditure elasticity with respect to any one category of output to be greater than or less than unity. For a unit expenditure elasticity in each category of output we require the coefficients on the separate (logarithmic) expenditure terms to sum to zero. Finally, it is also apparent from [10] and [11] that the adopted functional form allows the marginal propensities and the elasticities to vary over time as both are dependent on the respective output and expenditure shares.

It is interesting to note that there is nothing in [9] to prevent the estimated long-run marginal propensities from being negative. Indeed a number of such propensities were negative in the static system estimated

in Darby and Wren-Lewis (1990). It is difficult to think of many economic rationales for this result. Whilst certain types of expenditure, such as subsidies to take agricultural land out of use, can reduce particular categories of production, such expenditures do not enter final expenditure at factor cost. Only if transfer expenditure is correlated with final expenditure might that component of government expenditure that enters final expenditure attract a negative coefficient in the relevant output category.

It is also possible that changes in the production function can alter the output shares, with a rise in intermediate imports reducing net domestic output for a given gross output level. However such effects arise from the supply side rather than from the composition of final expenditure and should therefore be reflected in prices. Our intention is therefore to test whether any freely estimated negative marginal propensities can be imposed at zero.

The uncompensated price elasticities in [9] are given by:

$$\beta_{ih} \,/\, s_i^y = (\delta y_i/\delta p_h).p_h/y_i \quad [12]$$

The somewhat unconventional form of [12] is due to [9] being written in terms of real expenditure.

Many consumer demand models test restrictions such as homogeneity and symmetry in the price coefficients. One interesting feature of the move from a final demand to a net output system is that symmetry with respect to prices may no longer be appropriate, even if it holds in the original final demand system. In contrast homogeneity should carry across to the net output model. These points are illustrated in Appendix A using a linear expenditure model.

A further issue of importance is that of dynamic specification. The rejection of restrictions such as homogeneity is quite common in static demand models and is frequently attributed to the absence of some form of dynamic adjustment, see Deaton and Muellbauer (1980) and Winters (1984) for two such examples. The empirical results in Anderton *et al.*(1989) suggest that lagged dynamic effects are an important factor in the determination of imports of manufactured goods. If true, then dynamic adjustment must also be important for at least one other form of output in order that the adding-up constraints relating output to expenditure be satisfied. As Anderson and Blundell (1982,1983) emphasize, the choice of dynamic structure within singular systems is more appropriately carried out at the systems level rather than on an equation by equation level.

A general, linear first order dynamic system may be written as:

$$\mathbf{Y_t} = A\mathbf{Y_{t-1}} + B_1X_t + B_2X_{t-1} \qquad [13]$$

where $\mathbf{Y_t}$ is a (m x 1) vector of endogenous variables, $\mathbf{X_t}$ a (q x 1) vector of exogenous variables and **A**, $\mathbf{B_1}$ and $\mathbf{B_2}$ are appropriately dimensioned coefficient matrices. The long-run equilibrium parameters can be recovered by setting:

$$Y_t = (I - A)^{-1}(B_1 + B_2)X_t$$

or:

$$Y_t = \Pi X_t \qquad [14]$$

The main advantage of beginning with an unrestricted system such as [13] is that it will accommodate short-run demand disequilibrium if, for example, expenditure on particular goods is relatively inflexible in the short term. Systems such as [13] may arise from models with either costs of adjustment or habit persistence (if B_2 is zero). A static model is clearly nested within [13] as a special case.

One drawback with [13] is that any restrictions such as homogeneity imposed on the **B** matrices may only hold in the short-run. There is no guarantee that they will also hold in [14] even though theory suggests that it is in the long-run solution where such equilibrium restrictions might be expected to apply. To overcome this problem a transformation of [13] is required in order to permit direct estimation of the long run matrix Π.

Two possible solutions exist in the literature. The first employs the transform proposed in Bewley (1979) and more recently in Wickens and Breusch (1988). This re-writes [13] as :

$$\Delta Y_t = - (I - A)Y_{t-1} + (B_1 + B_2)X_t - B_2\Delta X_t$$

$$(I - A)^{-1}\Delta Y_t = - (Y_t - \Delta Y_t) + (I - A)^{-1}(B_1 + B_2)X - (I - A)^{-1}B_2\Delta X_t$$

$$Y_t = (I - (I - A)^{-1})\Delta Y_t + \Pi X_t - (I - A)^{-1}B_2\Delta X_t \qquad [15]$$

An instrumental variables technique is required to estimate [15] due to the presence of terms in ΔY on the right hand side.

An alternative approach is provided by Anderson and Blundell (1982,1983) who reparameterise [13] into a nonlinear form that also allows direct estimation of the long-run matrix. We can rewrite [13] as follows:

$$\Delta Y_t = -(I - A)Y_{t-1} + B_1\Delta X_t + (B_1 + B_2)X_{t-1}$$
$$= B_1\Delta X_t - (I - A)(Y_{t-1} - (I - A)^{-1}(B_1 + B_2)X_{t-1})$$

$$= B_1\Delta X_t - (I - A)(Y - \Pi X)_{t-1}$$
$$= B_1\Delta X_t - W(Y - \Pi X)_{t-1} \qquad [16]$$

This parameterisation is used in our empirical work below. Equation [16] may be viewed as a systems analogue of a single equation error-correction model. The adding up constraints $\Sigma Y_i=1$ and $\Sigma\Delta Y_i=0$ imply that the explanatory variables appearing in each equation of [16] are perfectly collinear and that the variance-covariance matrix is therefore singular. This can be overcome by arbitrarily deleting one equation from the system. Thus in estimation the last elements of $\mathbf{\Delta Y_t}$ and $\mathbf{Y_{t-1}}$ are omitted, along with the last row of Π. Thus Π and **W** become (m-1 x m-1) and (m-1 x q) matrices. The adding-up constraints enable the omitted parameters to be recovered.

IV. Empirical Results

The starting point for the empirical work is given by equation [2]:

$$D_N + M = TDE + X \qquad [2]$$

where D_N denotes the output estimate of Gross Domestic Product, M is total imports, X is exports and TDE is total final domestic expenditure at factor cost:

$$TDE = C + I + G + SB + R - A \qquad [17]$$

where R denotes the residual error between the output and expenditure estimates of GDP and A is the factor cost adjustment.

Three components of the left hand side of [2] were removed prior to estimation - ownership of dwellings, oil imports and domestic oil production. Their expenditure counterparts are given by the imputed rent components of consumers' and government expenditure, consumers' expenditure on petrol and gas, oil exports and other oil used to produce goods and services to meet final domestic demand. The removal of oil output prevents the econometric problems that could arise from the sudden expansion in domestic production from the mid 1970s onwards.

Two additional adjustments were required. First, some of the individual types of imported goods are only available on an Overseas Trade Statistics (OTS) basis, even though aggregate imports M are measured on a Balance of Payments (BOP) basis. Thus we had to allocate a BOP/OTS adjustment to some categories of import to ensure that [2] continued to hold. The second adjustment was to allocate the factor cost adjustment so as to ensure that the individual expenditure components were all on a factor cost basis. This was done by splitting A into three components, excise duty on petrol and gas, other oil taxes and other non-oil duties. Details on all these adjustments are given in the Data Appendix.

The remaining categories of domestic output and imports were combined in a way that reflected the ready availability of price data. This gave three categories of domestic output - manufacturing, public services and the non-oil, non-manufacturing private sector - and three categories of imports - manufactures, services and other. Further details are given in the Data Appendix. The price indices used for public services output and private sector non-manufacturing were a price index for public authority procurement and the GDP deflator adjusted so as to exclude manufacturing, oil and the public sector.

Expenditure was initially split into six categories, investment, non-oil exports, public expenditure, stockbuilding, consumers' expenditure and the residual error. Consumers' expenditure, investment and government expenditure were adjusted so as to exclude imputed rent, consumption of oil and taxes and subsidies.

Charts 1 and 2 show the shares of the main expenditure components in our adjusted measure of total final expenditure. Exports, investment and government expenditure were all around one fifth of the total in the 1970s but have subsequently behaved quite differently, with a particularly noticeable fall in the government expenditure share in the last decade. Consumption expenditure, by contrast has shown a marked rise in its share over the same period. Charts 2 to 4 show the corresponding movements in the shares of domestic output and imports. Most noteworthy is the steady increase in the share of manufactured imports from around 5 per cent in the mid 1960s to around 18 per cent in 1991. This rise is largely but not completely offset by a fall in the share of domestic manufacturing. The charts are also useful in illustrating how particular output categories may be closely related to particular forms of expenditure. The closest relationship holds between public sector output and expenditure but other shares show some signs of synchronicity, for example between consumption and domestic non-manufacturing output, shown in chart 2.

The set of explanatory variables was augmented by a linear time trend and two dummy variables, one for the three-day week in 1974 and one to take account of the miners strike in 1984/5. The time trend may pick up a number of otherwise excluded effects such as non-price

competitiveness. Darby and Wren-Lewis (1990) find the dummies to be significant in their empirical work. We would expect that the primary effect of the 1984 strike would be to increase the share of imported basic materials at the expense of private sector non-manufacturing, since this latter category includes non-oil energy output. We test the validity of this restriction below.

The discussion in Section II emphasised the importance of beginning with a fairly general dynamic specification. In practice the choice of the initial model is determined by both the available sample and also by possible programme constraints. With six price indices and six expenditure categories there are 12 variables in the **X** matrices (excluding constants, dummies and trends). Thus the most general model with which we could begin estimation was:

$$Y_t = \Sigma_1^3 A_i Y_{t-i} + \Sigma_0^3 B_i X_{t-i} \qquad [18]$$

Estimation was on a quarterly data set from 1968Q1-1991Q3, with the public services equation being deleted and recovered from the adding-up constraints. A simultaneous equations technique was used to take account of contemporaneous correlation between the error terms across equations.

All restrictions in the empirical work are tested using likelihood-ratio test statistics. As the standard tests are only valid asymptotically, they may result in over rejection in small samples (Bera *et al.*,1981). For the test statistics reported below we follow Van Heeswijk *et al.*(1990) in utilising the small sample correction proposed by Italianer (1986). The correction factor C is equal to $0.5(f_u + f_r)$ where f_u and f_r are small-sample correction factors for the unrestricted and restricted systems with:

$$f_i = (nT - p_i - 0.5(n)(n+1)) / nT \qquad (i = u,r) \qquad [19]$$

where n denotes the number of estimated equations, T the sample size and p_i the number of parameters.

The sequence of restrictions we imposed on [18] in the search for a more parsimonious general model are summarised in Table 1. LRC(i) denotes a corrected likelihood ratio test statistic distributed χ_i^2 and an asterisk denotes a statistic significant at the 5% level. The results suggest that Model 3 (corresponding to [13]) be chosen as a maintained structure since the critical values for LRC(85) and LRC(170) at the 5% level are approximately 107.5 and 201 respectively. It is interesting to note that the restrictions required to obtain a static model (Model 6) are heavily rejected.

Table 1: Tests on the dynamic structure

Model 1: $Y_t = \Sigma_1^3 A_i Y_{t-i} + \Sigma_0^3 B_i X_{t-i}$	
Model 2: $Y_t = \Sigma_1^2 A_i Y_{t-i} + \Sigma_0^2 B_i X_{t-i}$	Model 2 v Model 1: LRC(85)=92.6
Model 3: $Y_t = A_1 Y_{t-1} + \Sigma_0^1 B_i X_{t-i}$	Model 3 v Model 2: LRC(85)=96.9
	Model 3 v Model 1: LRC(170)=196.6
Model 4: $Y_t = \Sigma_0^1 B_i X_{t-i}$	Model 4 v Model 3: LRC(25)=110.5*
Model 5: $Y_t = A_1 Y_{t-1} + B_0 X_t$	Model 5 v Model 3: LRC(60)=125.5*
Model 6: $Y_t = B_0 X_t$	Model 6 v Model 3: LRC(85)=226.5*

Although the general restrictions on Model 3 reported in Table 1 were not accepted by the data, it was possible to impose a number of restrictions on the general model to obtain a more parsimonious specification with both price homogeneity and non-negative marginal expenditure propensities. In all a total of 84 restrictions were imposed on [16], with 53 of these being on the long-run parameters in the Π matrix and the adjustment parameters in the **W** matrix. The restrictions are acceptable against the general first order dynamic model [LRC(84)=92.6].

The resulting long-run expenditure and time trend coefficients are reported in Table 2a, along with the long-run t-statistics. These statistics may be interpreted as tests of whether the elasticity of output with respect to a particular expenditure share differs significantly from the share of that category of expenditure in total expenditure. A number of coefficients were restricted in order to avoid negative elasticities (or equivalently, negative marginal propensities). For example, when freely estimated the government expenditure effect in the manufacturing imports equation and the stockbuilding effect in the public services equation were both negative. Fifteen restrictions were imposed in all [LRC(15)=14.2].

One additional feature of interest in Table 2a is that it proved possible to impose the restriction that the long-run time trend in the domestic manufacturing equation is equal and opposite to the time trend in the manufacturing import equation [LRC(1)=0.02].

Table 2a: Long-run expenditure coefficients

	$\ln(\bar{C})$	$\ln(\bar{I})$	$\ln(\bar{X})$	$\ln(\bar{G})$	SB/E	RES/E	T
1. DMF	.01 (-)	.0411 (6.6)	.0267 (2.4)	-.0275 (-)	.0706 (1.2)	.0706 (1.2)	-.00136 (13.4)
2. MMF	.0087 (1.7)	.0087 (1.7)	.0038 (0.3)	-.0200 (-)	.3673 (4.2)	.1557 (1.9)	.00136 (13.4)
3. MSER	-.0089 (1.2)	-.0032 (0.7)	.0099 (2.6)	-.0090 (1.2)	.0301 (1.7)	.0301 (1.7)	-.00020 (4.0)
4. MOTH	-.0220 (-)	-.0090 (-)	.0049 (3.0)	.0049 (3.0)	.0456 (1.0)	-.0600 (-)	- (-)
5. DOTH	.0876 (10.5)	-.0076 (1.4)	-.0253 (3.7)	-.0150 (-)	-.3293 (4.0)	-.0399 (0.7)	- (-)
6. DPUB	-.0753 (-)	-.0300 (-)	-.0201 (3.2)	.0665 (40.1)	-.1844 (-)	-.1566 (2.6)	.00020 (4.0)

DMF : Domestic manufacturing
MMF : Imports of manufactures
MSER: Imports of services
MOTH: Other imports
DOTH: Domestic private sector non-manufacturing
DPUB: Public services

$\bar{C}$: consumers expenditure at factor cost, less imputed rent and oil consumption

$\bar{I}$: gross domestic fixed capital formation

$\bar{X}$: non-oil exports of goods and services

$\bar{G}$: public authority consumption less imputed rent

SB/E : ratio of stockbuilding to $(\bar{C}+\bar{I}+\bar{X}+\bar{G})$

RES/E : ratio of residual error to $(\bar{C}+\bar{I}+\bar{X}+\bar{G})$

T : time trend =1 in 1968Q1

The corresponding marginal propensities and elasticities are reported in Table 2b, using 1985 mean values. The figures may be interpreted as follows; a £100m increase in consumption at factor prices will raise the net output of domestic manufacturing by £23m. At the 1985 values this implies an elasticity of 0.46% with respect to consumption. The overall expenditure elasticity for any one category of output can be obtained by summing the individual elasticities along the relevant row. Thus in the case of manufacturing we have a total elasticity of 1.24%, although this is partially offset by the negative time trend.

Many of the marginal propensities are in accordance with prior expectations. For example over half of any additional public expenditure goes into public services with relatively little leaking into imports.

Table 2b: Marginal Propensities (and elasticities) for 1985

	$\bar{C}$	$\bar{I}$	$\bar{X}$	$\bar{G}$	SB	RES	T
1. DMF	0.23 (0.46)	0.45 (0.36)	0.31 (0.37)	0.05 (0.05)	0.28	0.28	(-0.47)
2. MMF	0.17 (0.46)	0.21 (0.22)	0.17 (0.26)	0.04 (0.05)	0.52	0.31	(0.63)
3. MSER	0.03 (0.22)	0.03 (0.10)	0.09 (0.44)	0	0.08	0.08	(-0.29)
4. MOTH	0	0	0.07 (0.33)	0.08 (0.27)	0.10	0	(0)
5. DOTH	0.57 (0.66)	0.31 (0.14)	0.25 (0.17)	0.28 (0.14)	0.03	0.32	(0)
6. DPUB	0	0	0.10 (0.13)	0.54 (0.55)	0	0.03	(0.08)

Exports appear to benefit domestic manufacturing, although around one-third of any extra expenditure adds to total imports. This finding may reflect increasing international specialisation of production and the consequent growth in intra-industry trade (Dunning,1988). Investment appears to be more import-intensive than consumers expenditure, with over half of any additional consumption benefiting domestic non-manufacturing (which includes the retail sector).

The long-run price coefficients are reported in Table 2c. In total some 22 restrictions were imposed, with a number of insignificant cross-price coefficients being set to zero and long-run price homogeneity being imposed. These restrictions were jointly accepted by the data [LRC(22)=23.5]. All the own-price coefficients are negative, although restrictions were required to ensure that this property held in the residual public services equation. In the absence of symmetry relatively few firm conclusions can be drawn, although domestic and imported manufactures appear to be substitutes, as do other domestic (including domestic services) and imported services. Service and manufacturing imports appear to be complements, although this may possibly reflect some colinearity arising from exchange rate movements in their respective prices.

Table 2c. Long-run price coefficients

	$\ln(p_1)$	$\ln(p_2)$	$\ln(p_3)$	$\ln(p_4)$	$\ln(p_5)$	$\ln(p_6)$
1. DMF	-.0450 (4.6)	.0450 (4.6)	-	-	-	-
2. MMF	.0330 (2.3)	-.0165 (2.3)	-.0165 (2.3)	-	-	-
3. MSER	-	-.0191 (4.7)	-.0376 (6.8)	.0125 (4.4)	-.0103 (2.2)	.0545 (8.7)
4. MOTH	-.0434 (6.7)	.0290 (3.4)	.0226 (2.0)	-.0434 (6.7)	.0353 (7.5)	-
5. DOTH	.0555 (4.2)	-.0384 (4.1)	.0316 (2.5)	.0209 (3.4)	-.0150 (-)	-.0446 (7.1)
6. DPUB	-	-	-	.0100 (-)	-	-.0100 (-)

The **W** matrix of adjustment parameters (see [16]) is given in Table 2d, along with the goodness of fit for each of the individual equations. Zero restrictions were placed on **W** in a symmetric manner. In total 7 restrictions were imposed [LRC(7)=4.3]. All the diagonal elements are negative as might be expected. However, as Barr and Cuthbertson (1991) emphasise, this is not required for the system to be dynamically stable. A sufficient condition is that the eigenvalues of the estimated adjustment matrix have modulus less than unity[4]. The five independent eigenvalues in our model are 0.84, 0.29, 0.66, 0.43, and 0.55 and thus the system is stable.

Table 2d. Adjustment parameters

	DMF_{-1}	MMF_{-1}	$MSER_{-1}$	$MOTH_{-1}$	$DOTH_{-1}$	R^2	SE
1. DMF	-.1323 (3.5)	.1323 (3.5)	.1867 (1.3)	.2144 (2.6)	.1823 (2.7)	0.55	.00198
2. MMF	-.0687 (0.9)	-.4028 (7.1)	-.0373 (0.2)	-	-	0.59	.00260
3. MSER	-.0765 (1.7)	.0786 (1.7)	-.6566 (7.3)	-	.1627 (4.2)	0.62	.00106
4. MOTH	-.1003 (1.6)	-	-	-.6098 (6.5)	-.1166 (1.7)	0.76	.00182
5. DOTH	.2143 (2.3)	-	.2136 (1.2)	.1930 (1.9)	-.4390 (5.3)	0.58	.00284

The final set of long-run parameter restrictions were imposed on the coefficients on the strike dummies. A total of 6 restrictions were imposed in all:

(i) that the effect of the 1974 strike on imports of manufactures was the negative of the effect on domestic manufactures

(ii) that the 1984 strike had no effect on either domestic or imported manufactures

(iii) that neither strike had any effect on imports of services

(iv) that the effect of the 1984/5 strike on private non-manufacturing was the negative of the effect on other imports

These restrictions were not rejected by the data [LRC(6)=4.75]. The implication of the restrictions for the residual equation is that the share of public services in total output rose during the three-day week, but was unaffected by the miners strike.

Further checks on the adequacy of the restricted model were performed by conducting tests for the presence of serial correlation and structural stability. The presence of serial correlation of order ρ in a simultaneous equations model implies that:

$$\mathbf{AY} + \mathbf{BX} + \mathbf{R}_{\rho}\mathbf{U}_{-\rho} = \mathbf{E} \qquad [20]$$

where $\mathbf{U}_{-\rho}$ denotes the matrix of lagged residuals. A more extensive analysis is contained in Godfrey (1988). A likelihood ratio test of $\mathbf{R}=0$ provides a valid test. Tests on the restricted model failed to reveal any sign of significant first or fourth order serial correlation, with the respective test statistics being [LRC(25)=24.7] and [LRC(25)=33.9].

The structural stability test due to Anderson and Blundell (1984) has the form:

$$2\,[(T/T_1)L_1 + (T/2)\ln(T/T_1) - L] \qquad [21]$$

Here T and L denote the complete sample size and log-likelihood and T_1 and L_1 denote the values for a restricted sample size. The test statistic is distributed as χ^2 with $n(T - T_1)$ degrees of freedom. We removed the last 20 observations from the original sample and re-estimated the final model over 1968Q1-1986Q3. The resulting test statistic [LR(100)=41.8] fails to provide any evidence of instability. Taken together, these diagnostic tests suggest that the coefficients in the restricted model present a reasonable representation of the data.

V. An Illustrative Simulation

One question of interest concerns the time that it would take for our estimated model to settle down following a permanent shock to either prices or to one of the expenditure components. To investigate this issue we constructed a simulation base by holding all of the explanatory variables at their 1991Q3 values and allowing the system to run to convergence. Charts 5a and 5b show the dynamic response paths of the individual output categories following a permament 1% rise in the level of consumers' expenditure.[5]

The main point that emerges is that whilst most output categories move towards equilbrium quite quickly, it takes some time before they fully settle down. In part this reflects some overshooting arising from the short-run dynamic effects. This overshooting is particulalry marked in the case of service and other imports. As this category includes imports of food, drink and tobacco the reported responses suggest that it might prove useful to test whether separate effects can be found from non-durable and durable consumption.

It is also of interest to compare the properties of the new model with the equivalent partial simulation (with prices held fixed) conducted on the present version of the National Institute model as described in NIESR (1992). This explains domestic output using the static system described in Darby and Wren-Lewis (1990), relating output shares to components of domestic expenditure and to imports. Imports are determined using separately estimated single equation models. Thus the functional form of the domestic output and import equations differs, as do the explanatory variables used in the respective equations.

Charts 6a and 6b show the respective dynamic responses following a permanent 1 per cent in consumption. There are some points of similarity with the new model, with a sizable response in domestic non-manufacturing and some overshooting being observed in the other imports category. The main difference is that there is little sign of all the output categories setttling down, although service and other imports do appear to attain an equilibrium. The main problems clearly lie with domestic manufacturing output and manufacturing imports, with the dynamic responses trending over time. This serves to illustrate the potential pitfalls that can arise from the failure to jointly model systems of variables subject to a number of adding-up constraints.

VI. Conclusions

This paper has presented some preliminary results from the use of a flexible dynamic demand model to analyse the joint determination of domestic output and imports. The adoption of a simultaneous equation model ensures consistency in that it enables the 'residual equation' implied by the adding-up constraints to have the same form as the remaining behavioural equations. Our use of a systems approach is supported by the importance of spillover effects from one category of demand into another. The marginal expenditure elasticities obtained appear plausible and the simultaneous equation diagnostic statistics we present fail to reveal any obvious signs of misspecification. Further work might usefully include both a more detailed disaggregation of the individual expenditure categories and a more extensive analysis of the factors determining the demand for intermediate inputs into production.

Footnotes

1. We are ignoring the possibility of exports being supply driven. All supply effects are therefore implicitly consigned to the export price equation, implying that producers are price setters.

2. We assume that the marginal rate of substitution between domestically produced and imported intermediates is independent of the amount of other factors of production in use. We also assume that the price of intermediate goods from industry *i* is the same as the price of goods for final demand.

3. In contrast, most consumer demand systems use value shares as price indices have to be used to obtain any volume data. For a related exception, see Anderton *et al.*(1989).

4. If the disequilibrium term for asset *m* is excluded from [13], then the estimated adjustment matrix is $\mathbf{A} = (\mathbf{A}_1, \mathbf{A}_2 \ldots \mathbf{A}_{m-1})$. The full model is given by $\mathbf{Y}_t = (\mathbf{I} + \mathbf{A}^*)\mathbf{Y}_{t-1}$, where $\mathbf{Y}$ is (m x 1), $\mathbf{I}$ is (m x m), $\mathbf{A}^*$ is $(\mathbf{A}_1 \ldots \mathbf{A}_{m-1}, \mathbf{0})$ (m x m), $\mathbf{0}$ is a (m x 1) column vector of zeroes. One of the eigenvalues of $(\mathbf{I} + \mathbf{A}^*)$ is unity. Stability requires that the other (m-1) have modulus less than unity.

5. These are only partial responses. In a full econometric model the change in demand will also result in price changes.

APPENDIX A

This Appendix illustrates that symmetry may be an extremely strong restriction in a net output system relating output to expenditure and prices, even if it is a property of the underlying final demand model.

Consider a linear expenditure function for 3 goods in which final demand for each good q_i may be expressed as a linear function of total expenditure E and the respective product prices p_i (i=1,2,3). Assume also that there are 3 industries with output for final demand produced by one industry using intermediate inputs from the other two. Letting Y_i denote the net output of industry *i*, we have a system of the form:

$$\mathbf{Q} = \mathbf{MY} = \mathbf{ZX}$$

The matrix **Z** and the vector **X** can be partitioned into separate price and expenditure effects so that:

$$\mathbf{Q} = \Gamma.\mathrm{E} + \beta.\mathrm{P}$$

or:

$$\begin{bmatrix} q_1 \\ q_2 \\ q_3 \end{bmatrix} = \begin{bmatrix} m_{11} & m_{12} & m_{13} \\ m_{21} & m_{22} & m_{23} \\ m_{31} & m_{32} & m_{33} \end{bmatrix} \begin{bmatrix} Y_1 \\ Y_2 \\ Y_3 \end{bmatrix} = \begin{bmatrix} \Gamma_1 \\ \Gamma_2 \\ \Gamma_3 \end{bmatrix} \mathrm{E} + \begin{bmatrix} \beta_{11} & \beta_{12} & \beta_{13} \\ \beta_{21} & \beta_{22} & \beta_{23} \\ \beta_{31} & \beta_{32} & \beta_{33} \end{bmatrix} \begin{bmatrix} p_1 \\ p_2 \\ p_3 \end{bmatrix} \qquad [1]$$

Here m_{11} represents the proportion of $Y_1^{\cdot}$ used in the production of q_1. A number of adding-up constraints given by $\Sigma q_i = \Sigma Y_i = E$ can be imposed. These imply that:

$$\mathbf{M} = \begin{bmatrix} m_{11} & m_{12} & m_{13} \\ m_{21} & m_{22} & m_{23} \\ (1-m_{11}-m_{21}) & (1-m_{12}-m_{22}) & (1-m_{13}-m_{23}) \end{bmatrix} \qquad [2]$$

$$\Gamma = \begin{bmatrix} \Gamma_1 \\ \Gamma_2 \\ (1-\Gamma_1-\Gamma_2) \end{bmatrix} \qquad [3]$$

If symmetry is also imposed on the price responses, then the β matrix becomes:

$$\beta = \begin{bmatrix} \beta_{11} & \beta_{12} & -(\beta_{11} + \beta_{12}) \\ \beta_{12} & \beta_{22} & -(\beta_{12} + \beta_{22}) \\ -(\beta_{11} + \beta_{12}) & -(\beta_{12} + \beta_{22}) & (\beta_{11} + 2\beta_{12} + \beta_{22}) \end{bmatrix} \qquad [4]$$

Equations [1]-[4] can be used to solve for net output in terms of expenditure and relative prices where:

$$\mathbf{Y} = \mathbf{M}^{-1}\Gamma.\mathrm{E} + \mathbf{M}^{-1}\beta.\mathrm{P}$$
$$= \mathbf{M}^{-1}\Gamma.\mathrm{E} + \mathbf{C}.\mathrm{P} \qquad [5]$$

Our main interest lies in whether the symmetry in β carries across into the **C** matrix. Letting λ_{ij} denote the (i,j)th cofactor of **M** and Θ denote $(1/|\mathbf{M}|)$, the three elements of the first row of **C** can be expressed as:

$$c_{11} = \Theta[\lambda_{11}\beta_{11} + \lambda_{21}\beta_{12} - \lambda_{31}(\beta_{11} + \beta_{12})] \qquad [6a]$$

$$c_{12} = \Theta[\lambda_{11}\beta_{12} + \lambda_{21}\beta_{22} - \lambda_{31}(\beta_{12} + \beta_{22})] \qquad [6b]$$

$$c_{13} = \Theta[-\lambda_{11}(\beta_{11} + \beta_{12}) - \lambda_{21}(\beta_{12} + \beta_{22}) + \lambda_{31}(\beta_{11} + 2\beta_{12} + \beta_{22})] \qquad [6c]$$

Equations [6a]-[6c] indicate that homogeneity will clearly carry across from the final demand system to the net output system. Given that the standard (column) adding-up constraints must also hold for **C**, symmetry will also carry across if $c_{12} = c_{21}$. This implies:

$$0 = c_{21} - c_{12}$$
$$= \lambda_{12}\beta_{11} + \lambda_{22}\beta_{12} - \lambda_{32}(\beta_{11} - \beta_{12}) - \lambda_{11}\beta_{12} - \lambda_{21}\beta_{22}$$
$$+ \lambda_{31}(\beta_{12} + \beta_{22}) \qquad [7]$$

Substituting in for the cofactors, this reduces to a requirement that:

$$0 = \beta_{11}(m_{23} - m_{21}) + \beta_{12}(m_{11} - m_{13} - m_{22} - m_{23}) + \beta_{22}(m_{12} - m_{13}) \qquad [8]$$

Thus even if symmetry holds in the final demand system, there seems little reason why it should carry across into the net output system. This is not to say that symmetry can never be imposed as there are two special cases where it does carry across:

(1) If there are no intermediate inputs, so that $m_{12}=m_{13}=m_{21}=m_{23}=0$, and $m_{11}=m_{22}=1$, then [8] reduces to $\beta_{12}(m_{11} - m_{22})$.

(2) If $\beta_{11}=\beta_{12}=\beta_{22}$ then [8] reduces to $\beta_{11}(m_{22} + m_{12} - m_{11} - m_{21})$. This will be satisfied if $Y_1/(q_1 + q_2)$ is equal to $Y_2/(q_1 + q_2)$.

CHART 1: SHARES OF ADJUSTED INVESTMENT, EXPORTS AND GOVERNMENT EXPENDITURE IN ADJUSTED TOTAL FINAL EXPENDITURE (%)

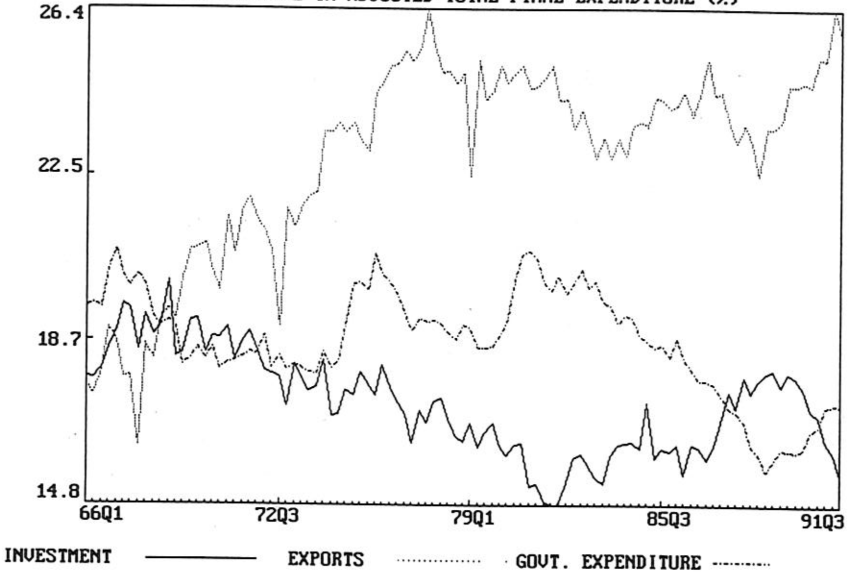


CHART 2: SHARES OF ADJUSTED CONSUMERS' EXPENDITURE AND DOMESTIC NON-OIL NON-MANUFACTURING PRIVATE SECTOR OUTPUT IN FINAL EXPENDITURE (%)

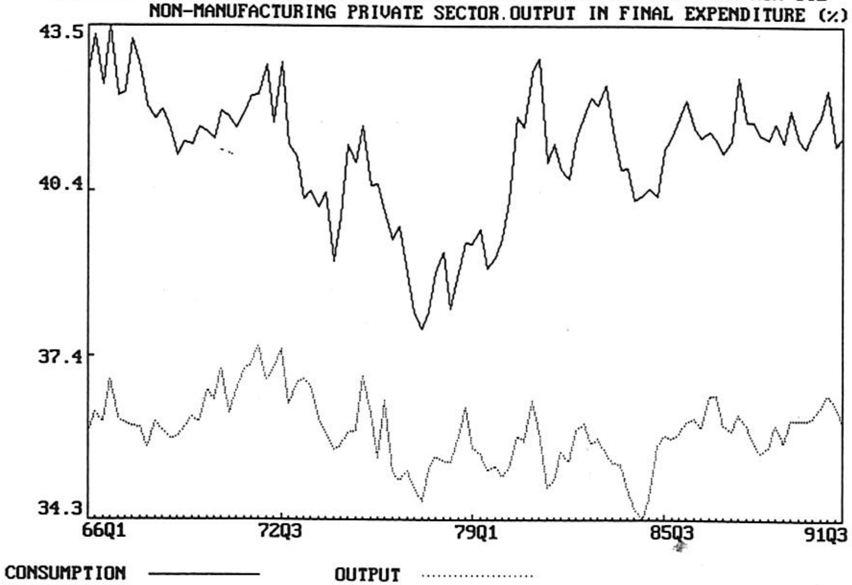


CHART 3: SHARES OF DOMESTIC MANUFACTURING OUTPUT, IMPORTS OF MANUFACTURES AND PUBLIC SECTOR OUTPUT IN ADJUSTED TOTAL FINAL EXPENDITURE (%)

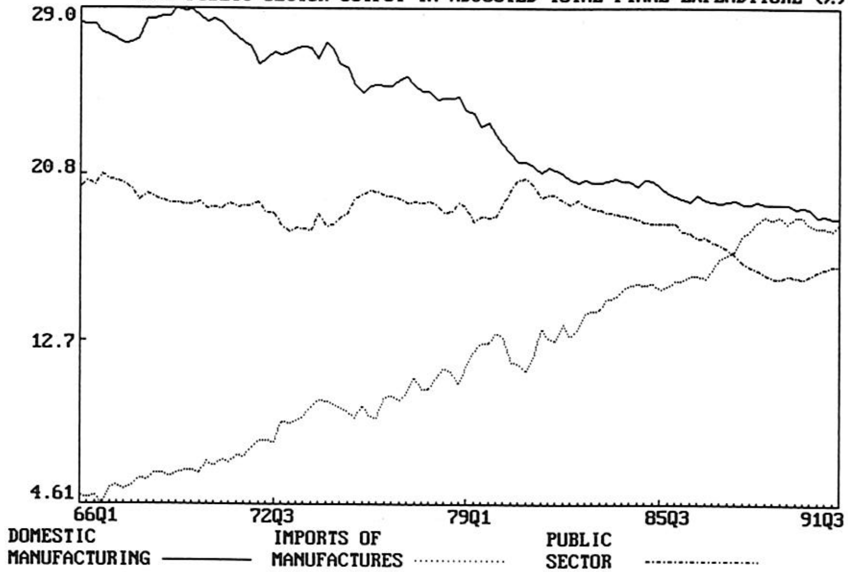


CHART 4: SHARE OF OTHER IMPORTS AND SERVICE IMPORTS IN ADJUSTED TOTAL FINAL EXPENDITURE (%)

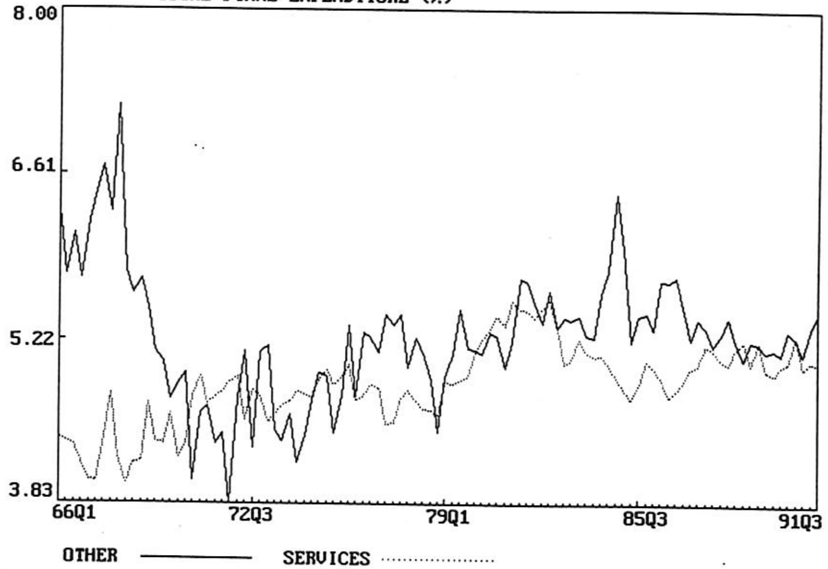


CHART 5a: PERCENTAGE CHANGE IN DOMESTIC OUTPUT CATEGORIES FOLLOWING A PERMANENT 1% RISE IN CONSUMERS EXPENDITURE (%)

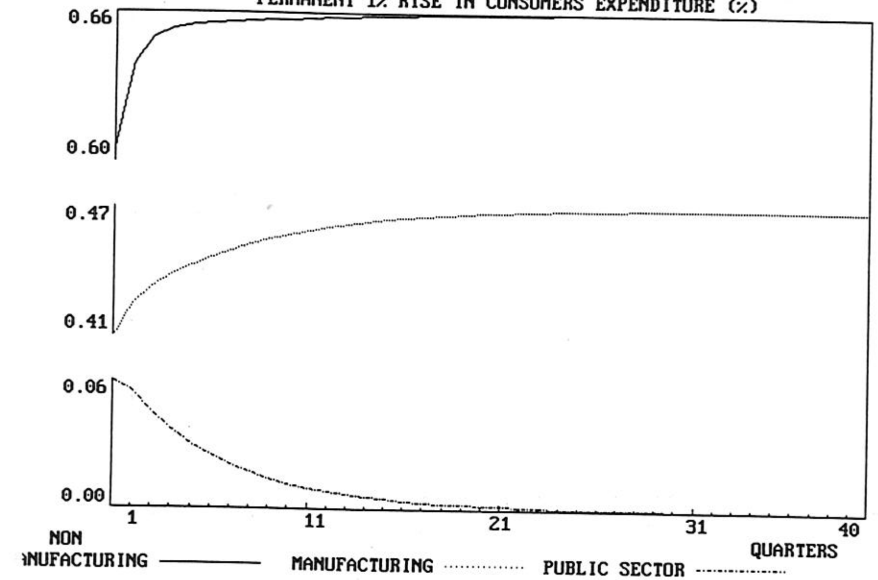


CHART 5b: PERCENTAGE CHANGE IN IMPORT CATEGORIES FOLLOWING A PERMANENT 1% RISE IN CONSUMERS EXPENDITURE (%)

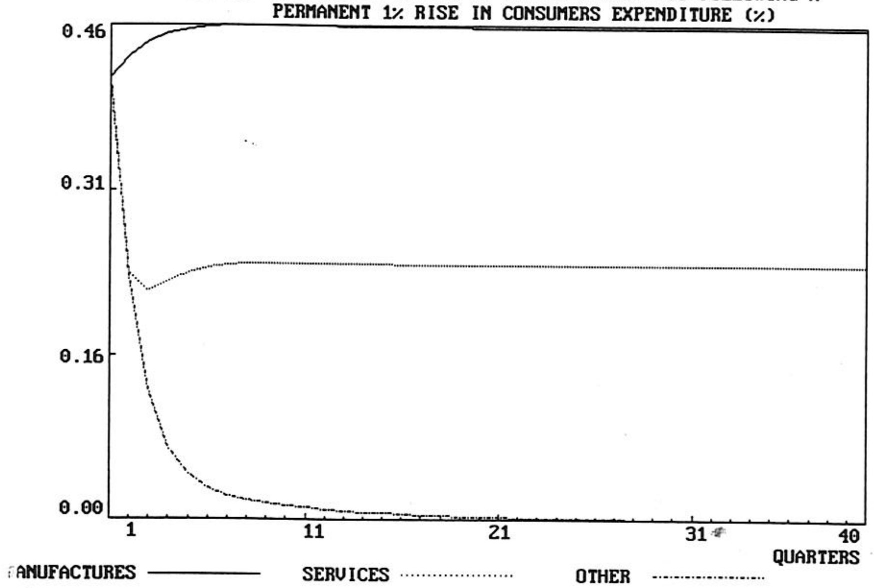


CHART 6a: PERCENTAGE CHANGE IN DOMESTIC OUTPUT CATEGORIES FOLLOWING A PERMANENT 1% RISE IN CONSUMERS EXPENDITURE (CURRENT MODEL)(%)

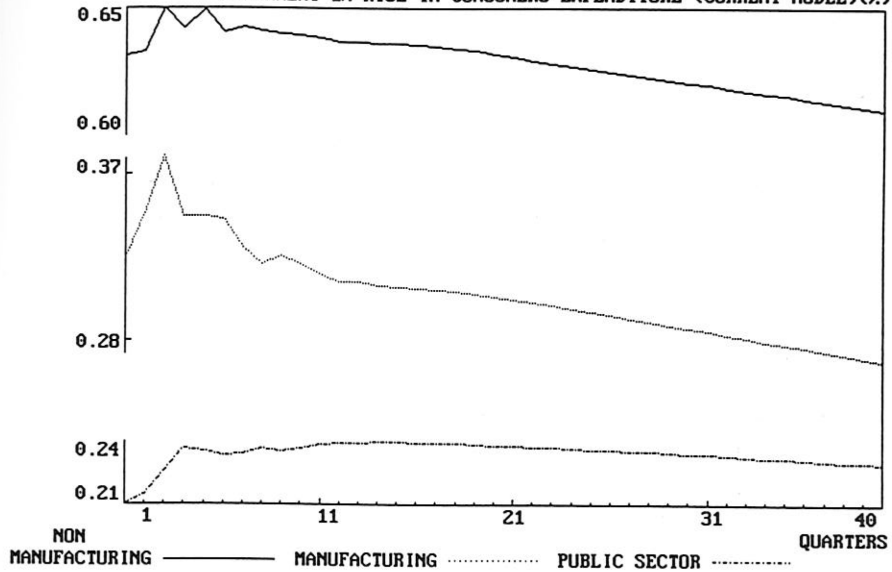
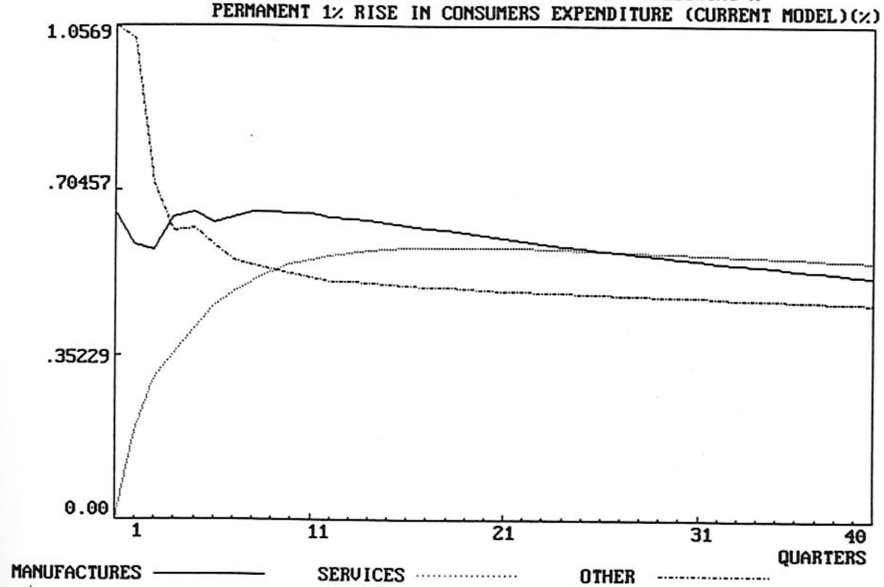


CHART 6b: PERCENTAGE CHANGE IN IMPORT CATEGORIES FOLLOWING A PERMANENT 1% RISE IN CONSUMERS EXPENDITURE (CURRENT MODEL)(%)



Data Appendix

A - Factor cost adjustment, £m, 1985.

A_{PG} - Taxes on petrol and gas expenditure, £m 1985.

C - Consumers' expenditure, £m 1985.

$\bar{C} = C - C_{IR} - C_{PG} - [A - A_{PG}] - [D_{OIL} + M_{OIL} - C_{PG}]*C/(C+I+G+X)$

C_{IR} - Imputed rent component of consumers' expenditure, £m 1985.

C_{PG} - Consumers' expenditure on petrol and gas at market prices, £m 1985

D_E - Value of GDP, expenditure estimate, £m 1985; $R = D_N - D_E$

D_{IR} - Value of ownership of dwellings, £m 1985.

DMF - Value of manufacturing output, £m 1985.

D_N - Value of GDP, output estimate, £m 1985.

D_{OIL} - Value of domestic oil and gas extraction, £m 1985.

$DOTH = [D_N - D_{OIL} - D_{IR}] - DMF - DPUB$

G - Public Authority Procurement, £m 1985.

$\bar{G} = G - G_{IR} - [D_{OIL} + M_{OIL} - C_{PG}]*G/(C+I+G+X)$

$G_{IR} = D_{IR} - C_{IR}$

I - Gross domestic fixed capital formation, £m 1985.

$\bar{I} = I - [D_{OIL} + M_{OIL} - C_{PG}]*I/(C+I+G+X)$

M - Total import volume, £m 1985, BOP basis.

M_A - BOP/OTS import volume adjustment, £m 1985.

M_{MF} - Volume of manufactured imports, £m 1985, OTS basis.

$MMF = M_{MF} + M_A*M_{MF}/(M_{MF}+ M_O)$

$M_O = M - M_A - M_{OIL} - MSER$

$MOTH = M_O + M_A*M_O/(M_{MF}+ M_O)$

M_{OIL} - Imports of oil, £m 1985, BOP basis.

MSER - Imports of services, £m 1985, BOP basis.

p_1 - wholesale price of manufactures, 1985=100.

p_2 - price of imported manufactures, 1985=100

p_3 - price of service imports, 1985=100

p_4 - price of other imports, 1985=100

$p_5 = [p_E - .238*p_1 - .214*p_6 - .062*p_{OIL}] / .5418$

p_6 - price index for public authority procurement, 1985=100

p_E = GDP deflator at factor cost, 1985=100

P_{OIL} - oil price index, 1985=100,

SB - Value of physical increase in stocks and work in progess, £m 1985.

X - Total export volume, £m 1985, BOP basis.

$\bar{X} = X - X_{OIL} - [D_{OIL} + M_{OIL} - C_{PG}]*X/(C+I+G+X)$

X_{OIL} - Oil exports, £m 1985, BOP basis.

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