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Trade in manufactures

by

A C Hotson and K L Gardiner

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The object of this Technical Series of Discussion Papers is to give wider circulation to, and to invite comment upon, the econometric research work predominantly directed towards revising and updating the various Bank models. Any comments should be sent to the authors at the address given below.

The authors are grateful for helpful comments made by Dr I D Saville and other colleagues at the Bank, but the views expressed are their own, and not necessarily those of the Bank of England. The authors would like to thank Miss L Crockford for her help as a research assistant and Miss H Burdett for typing the manuscript.

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Contents

1

Introduction

This paper seeks to develop a structural model of the UK's trade in manufactures, treating such trade as dominated by oligopolistic suppliers. It represents part of a continuing research programme at the Bank directed towards improving our understanding of past and potential trade flows. Section 1 briefly reviews earlier research; Section 2 outlines a model of the sector; Sections 3 and 4 report estimated price and volume equations; Section 5 considers the tracking performance and structural stability of the chosen equations; and Section 6 provides a brief discussion of likely simulation properties, and considers the next stages in the research programme.

Review of earlier work

Past research on trade in manufactures has been concerned with the interrelationships between costs, prices and volumes: in particular, whether relative prices, relative costs or both should be included as measures of competitiveness in volume equations; the definition of demand in the volume equations; the role of home and overseas costs and prices in the determination of trade prices; and the impact of the pressure of demand on prices and volumes.

The way in which these relationships are modelled depends, in part, on the structure of factor input and output markets in manufactures. For example, the inclusion of cost competitiveness in a volume equation can be justified on the grounds that it is a predetermined variable in a reduced form. This would be appropriate if wholesale selling prices were flexible and endogenous, jointly determined with the volume of sales, while unit costs were predetermined, being set in fix-price factor input markets. To the extent that manufactures are differentiated products and/or sold by oligopolistic producers who set prices which are inflexible in the short run, it may, however, be appropriate to estimate structural equations as part of a recursive system in which volumes depend, in part, on prices, and prices depend on unit costs among other factors.

Enoch (1978) argued that, given the diversity of market structures, even within relatively narrow categories of good, it was not possible on a priori grounds to choose which of the various measures of competitiveness best explained movements in trade volumes. He therefore sought to test econometrically the various measures of competitiveness by putting them in equations incorporating the major factors influencing the volume of trade, and seeing how far they improved the explanation of past trends. In the light of these non-nested empirical tests, Enoch concluded that an index of relative unit labour costs (RULC) performed best at explaining movements in manufactured exports; and that, using the IMF procedure to adjust cyclically (normalise) the unit labour cost indices further improved its explanatory power. For imports of finished manufactures, there was less difference between the various measures.

The empirical basis of the use of RULC has, however, been questioned by Brooks (1981). He compared the manufactured export equations in the Bank, Treasury, National Institute and London Business School models: the Bank and HMT use variants of normalised RULC, but the NIESR and LBS use relative export prices and relative non-normalised costs respectively. Brooks argued that it was not possible to discriminate between these models by testing them against the data (either as nested or non-nested hypotheses). He found that the information contained in divergences between cost and price competitiveness did not help to explain movements in export volumes.

Researchers within HM Treasury, Richardson (1977) and more recently Ritchie and Hicklin (1981), have sought to rationalise the use of relative unit labour costs (RULC) as a composite variable incorporating both supply and demand side influences. By identity, RULC can be decomposed into a multiple of relative export prices, relative absolute profitability, and relative 'relative' profitability.

$$\mathrm{RULC} = \frac{C_L}{C_L^*} = \underbrace{\frac{p_x}{p_x^*}}_{\text{Relative export prices}} \cdot \underbrace{\frac{p_h^*/C_L^*}{p_h/C_L}}_{\text{Relative absolute profitability}} \cdot \underbrace{\frac{p_x^*/p_h^*}{p_x/p_h}}_{\text{Relative 'relative' profitability}}$$

	p	denotes product price
	C	unit cost
Superscript	*	overseas
Subscript	x	export goods
	L	labour
	h	home goods

The use of RULC in trade equations, rather than all three of the above-mentioned measures of relative prices and profitability, imposes the (testable) restriction that each measure has the same effect period by period on trade volumes. It is unlikely that the lag profile of these factors are, in fact, identical, and this is a potentially serious problem with the rationalisation.

2

Analytical Framework

In the model outlined below, manufacturing firms are price setters in the markets for their output. In any one period, prices are fixed, the resultant demand being met by adjustments to stocks and production: in this sense expenditure on manufactures is demand determined. From period to period, selling prices are adjusted in response to changes in unit costs (predominantly labour, but also wholesale material input prices), competitors' prices and excess capacity, the latter two factors modifying the mark up on unit costs: the supply decision is therefore reflected in the prices set for manufactures. Unit costs, as defined, are intended to measure average variable costs per unit of output; fixed costs (such as expenditure on plant and machinery) are excluded. Trade volumes are determined by demand: the overall size of the market for manufactured goods, and relative prices (inclusive of taxes) and the pressure of demand. In the remainder of this section, the structure of the maintained form of the model is outlined in more detail, various subsidiary hypotheses nested within the model are discussed, and a number of approaches to estimation are considered.

Prices

Manufacturers face a trade-off between sales (market share) and profits, competitors' prices being a key influence on the set of attainable combinations of sales and margins. Given the cost of gaining or recouping market share or adjusting production, firms may accommodate fluctuations which are perceived to be temporary in their profit margins, their objective being to maximise expected profits over a number of years: these are the product of sales and margins, less a contribution to fixed (mainly capital) costs, summed over the firm's planning horizon, with appropriate discounting for more distant periods. In the absence of any satisfactory measure of fixed costs, it is assumed that, in the long-run, the margin over unit costs required to cover fixed costs remains stable.

Companies may not adjust their selling prices immediately in response to changes in unit costs or competitors' prices because such changes may be transient, and there may be costs associated with changing their own prices: they may have given formal or informal commitments to customers not to change their prices too frequently. Specifying the equations with distributed lags is one way of modelling the delayed response: the extent to which recent movements in the explanatory variables are discounted would depend on the variability of the series itself and the costs of adjusting selling prices. Price setting agents' expectations about future costs and prices may differ depending on the source of the change: for this reason, it may be worthwhile to test whether the short run response to changes in competitors' prices (in sterling terms) due to nominal exchange rate movements differs from changes due to adjustments in their local currency price. It may also be possible to identify the effect of cyclical fluctuations in productivity on unit costs, and include such a variable separately rather than rely solely on the distributed lag on unit costs. Margins on traded goods may also be varied depending on the pressure of demand in the home market and overseas: excess capacity could encourage margin cutting in export markets in an attempt to promote sales to cover fixed costs.[1] High levels of capacity utilisation could also proxy expectations that demand is only temporarily strong, encouraging profit-taking (wide margins) rather than attempts to increase sales, particularly where varying output incurs considerable extra costs. Also, companies in industries with declining marginal costs may cut their margins over average variable costs as capacity utilisation or the pressure of demand increases.

The impact of certain taxes on margins could warrant their inclusion as a separate variable. Taxes on factor inputs,however, such as national insurance, are already included in unit costs and there seems to be little reason for separating them out unless they give rise to a differential short run response.[2]. On the other hand, taxes on (net) output, such as value added tax (VAT), and purchase taxes, do not appear to be fully reflected in selling prices in the short-run[3], and it may be appropriate to include a tax variable in the import price/mark up equation: exports are not subject to value added tax. If the impact of VAT on import margins is the same as that on domestic margins, it may be possible to model the behaviour of import prices (exclusive of VAT) using domestic wholesale prices (also exclusive

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[1] Winters (1976) has noted that a decline in total sales (at home and abroad) could necessitate higher margins to cover increased fixed costs per unit of output. Since fixed costs are largely sunk costs, this argument should perhaps be given little weight.

[2] If national insurance contributions became an instrument of short-run fiscal policy, this might give rise to a differential response for expectational reasons.

[3] 'Bank of England model of the UK economy'. Discussion Paper, September 1979.

of VAT) as a regressor; however, the impact of tariffs on import margins cannot be avoided because of the wedge driven between relative market prices and relative factor costs.

The maintained form equations are therefore specified as follows:

$$UXGM_t = f\ (COST,\ NORD,\ WPIM.ERUK,\ EER,\ POD)$$

$$UMGM_t = f\ (WOST.ERUK,\ NORW,\ PIMO,\ EER,\ POW)$$

Where:		
	UXGM	= Manufactured export price
	UMGM	= Manufactured import price
	COST	= Domestic unit costs
	WOST.ERUK	= Overseas unit costs in sterling terms
	WPIM.ERUK	= Overseas wholesale prices in sterling terms
	PIMO	= Domestic wholesale selling prices (exclusive of taxes)
	NORD	= Domestic cyclical variations in productivity
	NORW	= Overseas cyclical variations in productivity
	EER	= Effective exchange rate
	POD	= Capacity utilisation in UK
	POW	= Capacity utilisation overseas

The use of overseas wholesale prices differs from existing Bank practice in which overseas exporters' prices have been employed. The latter may have been appropriate in the past when UK exporters' main competitors were exporters from third countries. More recently, however, UK exporters have become more dependent on West European and United States markets where home producers are often the prime rivals. For this reason, overseas wholesale prices may be a better measure of competitors' prices than overseas export prices, although the two tend to move together.

The existing Bank model equations do not use unit costs, but home prices: domestic wholesale prices in the manufactured export price equation, and world manufactured export prices in the import price equation [see Bond (1981)]. The use here of unit costs rather than domestic wholesale prices would require that domestic margins do not have an independent influence on export margins: it is arguable that there is no reason for firms to equate export margins with margins on home sales, even in the long run, so long as these markets remain segmented by geography, language etc (incomplete international consumer arbitrage). As a result, it may not be appropriate to include margins on home sales as a modifier variable influencing export margins.

Although selling prices reflect unit costs which are predetermined at the time of their setting, margins may exert a feedback effect on unit costs in the longer term. A deterioration in cost competitiveness which squeezed export (and domestic) margins rather than relative prices, would be expected to encourage (over a long period of time) a redirection of investment and sourcing to other countries. Reduced investment would reduce productivity relative to that which would otherwise have occurred, raising unit costs and reducing price competitiveness.

In principle, therefore, the effects of (relative) profitability should be modelled by way of an investment function, and thence the effect of the capital stock (and other factors) on labour (and non-labour) productivity. Thus, supply side factors are important in the determination of trade volumes, but, in this approach, they influence trade via prices and thence demand.

Volumes

Price competitiveness and the overall size of the market determine the volume of demand for manufactures. The demand schedule is identifiable given the assumed infinite elasticity of supply at predetermined prices. In the short run, shocks to demand could give rise to involuntary destocking, output-based measures of market size thereby understating ex ante demand. The pressure of demand may, to the extent that retailers and domestic producers expect demand always to be normal, act as a proxy for involuntary destocking and result in a short run "overshooting" effect, with trade volumes playing a buffer role. Rather than insert an explicit variable to capture this effect, rational lags in the estimated equations will allow such a response if consistent with the data. The volume equations have been specified as follows:

XGMA = f (UXGM/WPIM.ERUK, TWIP)

MGMA = f (UMGM/PIMO, MAND)

Where: XGMA = Manufactured export volumes

MGMA = Manufactured import volumes

TWIP = UK trade weighted OECD industrial production

MAND = UK demand for manufactures

UXGM/WPIM.ERUK = manufactured export price competitiveness

UMGM/PIMO = manufactured import price competitiveness

The use of UK trade weighted OECD industrial production (TWIP) as a measure of overseas demand differs from existing Bank practice in which a measure of world trade has been used. The inclusion of demand for home produced goods is consistent with the use of domestic wholesale prices as a measure of the price of competing goods. TWIP has deficiencies: it includes some non-manufactures and excludes non-OECD countries, and requires the explicit specification of the dynamic response in the equation.[1] To the extent that OECD countries meet non-OECD countries' demand for manufactures, however, it will reflect their demand, but the weighting of countries which meet non-OECD demand should be revised to allow for this. Strictly speaking, overseas industrial production which meets UK home demand should also be excluded. Doubtless the overseas demand variable could be refined in various ways (see discussion of MAND in section on import volumes), but for present purposes it is regarded as adequate.

Estimation

Given their short run inflexibility, unit costs can be treated as being weakly exogenous in the import and export price equations. For the use of ordinary least squares estimation to be valid for the export price equation, the reasonable assumption has to be made that there is no contemporaneous feedback of UK export prices onto overseas wholesale prices. On the import side, import prices and domestic wholesale prices are more likely to be simultaneously determined, requiring the use of simultaneous estimation techniques. The short run inflexibility of prices with respect to volumes may mean that the regressors in the volume equations are weakly exogenous, allowing single equation OLS estimation.

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[1] To the extent that the lagged effect of world demand on UK exports is not atypical, the dynamic response of trade to changes in demand will be incorporated implicitly in a world trade variable.

Failing this, a number of other approaches to estimation can also be tried. Substituting the price equations into the volume equations yields a reduced form for (export) volumes in terms of domestic unit costs and overseas prices. If overseas prices are determined as a mark up on overseas unit costs, such an equation could be substituted for overseas prices, yielding an equation relating volumes directly to unit costs at home and abroad. The manufactured export volume equation estimated by Enoch (1978) can be interpreted as such a reduced form with a number of implicit restrictions. Further substitution of equations yields a reduced form relationship between volumes and the capital stock (see, for example, Batchelor (1977)).

The use of reduced form equations can give rise to problems when interpreting the properties of the trade sector as a whole. In the past, manufactured export volumes in the Bank model have depended on relative costs; export prices on home and overseas prices. Of itself, a change in export prices, with costs unchanged, would have no impact on volumes. This has sometimes been justified on the grounds that the adverse relative price effect on demand is offset by the beneficial effect of increased margins on supply. However, if the market for exports is in equilibrium or in excess supply, reduced demand would constrain actual export deliveries: the market would be in (further) excess supply. If the market is already in excess demand, export deliveries might increase. It seems likely that a change in price competitiveness, cost competitiveness remaining constant, would have some impact on volumes.

The use of cost competitiveness in a reduced form equation has already been justified for markets in which output prices are endogenous (flex-price), and unit costs are predetermined (fix-price). If this were the case, however, the price equations should include the same variables as the volume equations: unit costs at home and overseas, domestic and overseas demand. We are not aware of a set of estimated price and volume equations (for manufactured trade) which are consistent in this sense and have plausible properties; moreover, such a system of equations is under-identified so the reduced forms do not throw any light on the process whereby costs affect prices and thence volumes.

Finally, a number of researchers have included both supply and demand side variables in equations determining prices and volumes. Clearly, equations of this sort cannot be regarded as _structural_. Batchelor (1977) justified an export volume equation, which included relative prices and profitability as regressors, as a reduced form from which estimates of their structural parameters could be derived. In his model, export markets switch back-and-forth between regimes in which deliveries are supply and demand constrained depending on the pressure of demand. While the analytical basis of Batchelor's approach is of considerable interest, it is of use for interpreting developments in trade only if it yields credible estimates of the structural parameters of the model, and if it is possible to make satisfactory forecasts of the extent to which markets are going to be supply or demand constrained. Our attempts to estimate a varying parameter model similar to Batchelor's met with only limited success [see Hotson (1982)]. The supply side variables - relative profitability and the capital stock - tended to be insignificant or have perverse signs. Omitting the supply side variables gave rise to volume equations similar to those reported in Section 4.

3

Estimated Price Equations

Equations were estimated for the unit value indices (UVI) of manufactured exports and imports (SITC 5 to 9, inclusive of erratic items). This differs from existing practice in the Bank model on the import side, where separate equations are estimated for semi and finished manufactures. This would be useful if it were possible to distinguish between the price of imports used as intermediate inputs (affecting domestic unit costs), and the price of competing imports (affecting margins). Unfortunately, the semis/finished categorisation in the trade statistics does not satisfactorily capture this distinction: a significant proportion of finished goods appear to be intermediate inputs and some semis are both intermediate inputs and competing goods.

A log-linear functional form was used throughout, as were rational lags. In the maintained form, lagged dependent variables with lags t-1 and t-2, and independent regressors with lags t and t-1 were employed. The components of unit costs - earnings per man-hour, the volume of net output per man-hour, wholesale buying in prices - were entered as separate variables in logarithmic form.[1] The restriction that the response of prices to changes in earnings and productivity were equal and opposite was tested against the data, and found to be acceptable. Measures of output per unit of non-labour input were not available: no attempt was made to adjust for productivity improvements for non-labour inputs. In the maintained form, the freely estimated relative weights on unit labour costs

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[1] $\text{COST} = (\text{Earnings})^{a} . ((\text{Productivity})^{b} . \begin{pmatrix}\text{Wholesale}\\ \text{(buying in)}\\ \text{prices}\end{pmatrix}^{c}$

Earnings = ECMM/HMT
Productivity = MPRO/HMFT
Wholesale buying in prices = MBIP

The multiplicative form was used so that COST was nested within the log-linear maintained form in which its components were included separately.

Analogous IMF data was used for earnings and productivity in 10 overseas countries with exponential UK manufactured import weights. A series for overseas wholesale buying in prices is not available, and a proxy was constructed using available price indices for various categories of raw materials. The indices were initially included as free regressors in the general form: eliminating insignificant variables led to the use of (0.25 ln PFO$ + 0.75 ln UNME), the weights approximating the shares of energy and other raw materials respectively in total non-labour input costs.

and non-labour input costs were found to be 45:55 respectively for export prices; 55:45 for import prices. The export price weights were not well-defined however (unit labour costs and wholesale buying in prices were highly collinear); 60:40 weights were thought to be more plausible, and imposed a priori on the basis of input-output data; these weights were not rejected by the data. The 55:45 weights were retained for the import price equation.

The sequential exclusion of the longest lags where they were insignificant yielded the following restricted form equations ($COST_t$ and POD_t were excluded last being insignificant):[1]

$$\ln UXGM_t = \underset{(3.5)}{-\ 0.770} + \underset{(15.4)}{0.623} \ln UXGM_{t-1} + \underset{(6.2)}{0.269} \ln COST_{t-1}$$

$$+ \underset{(6.8)}{0.119} \ln (WPIM.ERUK)_t + \underset{(3.4)}{0.167} \ln POD_{t-1}$$

SEE = 0.0104

$\bar{R}^2 = 0.9996$ 1967 I to 1981 IV

LM test for residual autocorrelation: $X^2(5) = 3.1$

For import prices:

$$\ln UMGM_t = \underset{(11.3)}{0.023} + \underset{(9.8)}{0.510} \ln UMGM_{t-1} + \underset{(12.4)}{0.387} \ln (WOST.ERUK)_t$$

$$+ \underset{(3.4)}{0.102} \ln \left(\frac{PIMO}{1 + TAR}\right)_{t-1}$$

SEE = 0.0145 1967 II to 1980 IV

$\bar{R}^2 = 0.9993$

LM test for residual autocorrelation: $X^2(5) = 6.6$

[1] The selection of the restricted form specifications of all the equations from their maintained forms is outlined in Annex II.

The export price equation was estimated using ordinary least squares, the maintained form import price equation using two stage least squares because of the possible simultaneity between domestic wholesale and import prices. The restricted form import price equation was however found to be recursive with respect to domestic wholesale prices. Tariffs on imports impose a wedge between import prices (UMGM) and the final selling price of imports, which could affect their mark up. An attempt was made to allow for this by adjusting domestic prices (PIMO/(1 + TAR), where TAR = tariff rate)[1] on the assumption that a tariff is similar in its effect on net import prices to a subsidy on domestic goods.

The export price equation is slightly over-homogeneous, the relative long run weight on home unit costs and competitors' prices being 71:32; the import price equation is homogeneous, the relative weights being 79:21. Long run homogeneity could have been imposed in the maintained form of the export price equation on a priori grounds: this was tried but gave rise to an equation with less plausible properties - the relative weight on domestic unit costs was markedly lower and autocorrelation was prevalent in the residuals. Non-homogeneity may be a feature of estimated equations because of measurement errors; this property should be borne in mind if such equations are simulated over long periods. The short run differential responses of prices to changes in both productivity and the nominal exchange rate were found to be insignificant or perverse, and were excluded.

Capacity utilisation was found to have a significant positive effect on export margins, but no significant effect on import prices.[2]

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[1] TAR is the average ex post rate of protective duties on imports of SITC categories 5-8. Current value data is available on an annual basis in the Annual Reports of HM Customs and Excise. This is divided by the current value of manufactured imports to derive the rate. Linear interpolation was used to obtain quarterly observations.

[2] Domestic capacity utilisation is defined as $MPRO/\overline{MPRO}$ where $\overline{MPRO}$ is a linear interpolation between peaks which occurred in 1965 Q2, 1970 Q4, 1973 Q1, 1974 Q2 and constant since latest peak in 1979 Q2.
Overseas capacity utilisation is defined as $TWIP/\overline{TWIP}$, peaks occurring in 1960 Q1, 1974 Q1 and 1980 Q1. [A more sophisticated model of potential output, using an aggregate production function for the manufacturing sector would be preferable [eg Artus (1977)], but research has so far failed to find one considered adequate for use in the Bank model.]

4

Estimated Volume Equations

Volume equations were estimated for manufactured exports and imports (SITC 5-8, exclusive of erratic items, seasonally adjusted)(1). Were it possible to identify goods sold on fix- and flex-price markets from the trade statistics, there would be a case for modelling transactions in these markets separately. Unfortunately, the SITC categories aggregate across goods sold in both types of market. At a disaggregated level, it may, in any case, be difficult to obtain suitable measures of market demand or relative prices.

A log-linear functional form was used throughout, as were rational lags. Both manufactured import and export volumes were adjusted for temporary distortions to trade identified by the Department of Trade, and the residual effects on export volumes of strikes in 1967 Q4 (dock strike), 1972 Q3 and Q4 (dock strike) and 1979 Q1 and Q2 (road haulage dispute) were smoothed out by linear interpolation.[2]

In the export volume equation, the second lagged dependent variable and the lags on TWIP were insignificant, and excluded. A linear Almon profile with a single (leading) endpoint constraint was utilised in order to ensure a statistically-significant cumulatively negative response to a change in relative prices: in the free estimation, the only significant lag was at t-6. The restrictions were accepted by the data, though with some evidence of induced residual autocorrelation.

$$\ln XGMA_t = \underset{(6.1)}{3.710} + \underset{(2.8)}{0.300} \ln XGMA_{t-1} + \underset{(6.5)}{0.700} \ln TWIP_t + \underset{(4.6)}{0.181} \ln SPEC$$

$$+ \sum_{3}^{7} a_i \ln (UXGM/WPIM.ERUK)_{t-i}$$

---

(1) There is some small inconsistency in that the price equations include erratic items and SITC 9.

[2] The use of lagged dependent variables imposes a 'tail' on strike dummies; this could be avoided by imposing non-linear restrictions, but such an exercise seems excessive for what is a fairly minor problem with the data.

$a_3 = -0.0171 \quad a_4 = -0.0341 \quad a_5 = -0.0512$

$a_6 = -0.0682 \quad a_7 = -0.0853 \quad \Sigma a_i = -0.2559$ (4.3)

SEE = 0.0236 $\quad \bar{R}^2 = 0.9852 \quad$ 1967(I) - 1981(IV)

LM test for residual autocorrelation: $X^2_{(5)} = 9.5$

The long-run elasticity of XGMA with respect to TWIP was found initially to be greater than unity. To some extent, this may reflect other factors such as the increased liberalisation of trade flows in recent years. Following Beenstock and Warburton (1983), the ratio of world manufacturing trade to output (SPEC) was included as a separate variable, although a simple exponential time trend seemed to fit the data almost as closely with little change in the estimated parameters. The inclusion of an additional variable, be it SPEC or a time trend, in an attempt to capture such increased real international "openness" resulted in long-run homogeneity being accepted by the data. The use of the trend variable led to an unambiguous improvement in the goodness of fit, but the extent to which such a measure reflects accurately the reduction in global protection (for example) over the data period is uncertain. SPEC is plotted as Chart 1.

The long-run relative price elasticity is -0.37, with a mean lag of 6.1 quarters (the cumulative response is shown in Chart 2).

For the import volume equation, no satisfactory direct measure of the volume of UK demand for manufactures is available. A sales of manufactures series is published by the CSO (1), but intra-industry transactions are double counted and no corresponding price deflator is available. An indirect approach is needed: manufacturing value added is known, and input-output data can be used to gross up the series to include total non-manufactured inputs to the manufacturing sector (2). Imports can then be added to give a measure of UK demand.

In keeping with previous Bank research, a gross market for manufactures net of direct intra-sector duplication (MAND) was defined as:

(1) Business Monitor PQ 1002.

(2) If imports are to be added to domestic output to form a single market for manufactures, it may be desirable to value both series on a consistent basis. Imports are measured gross, and in the absence of input-output data for the rest of the world it is easier to gross-up domestic net output than to attempt to obtain the net equivalent of manufactured imports.

Chart 1

Ratio of World manufacturing trade to output

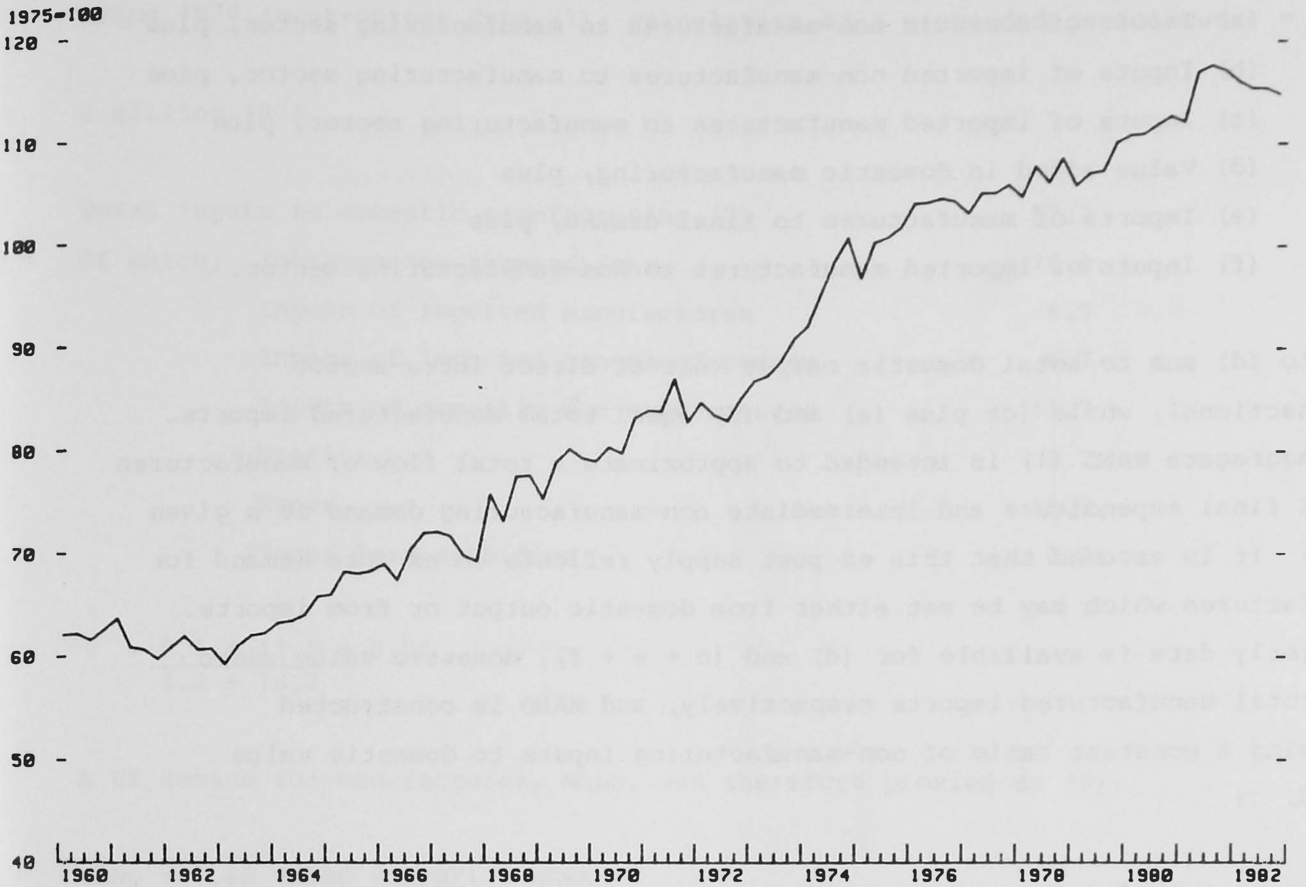
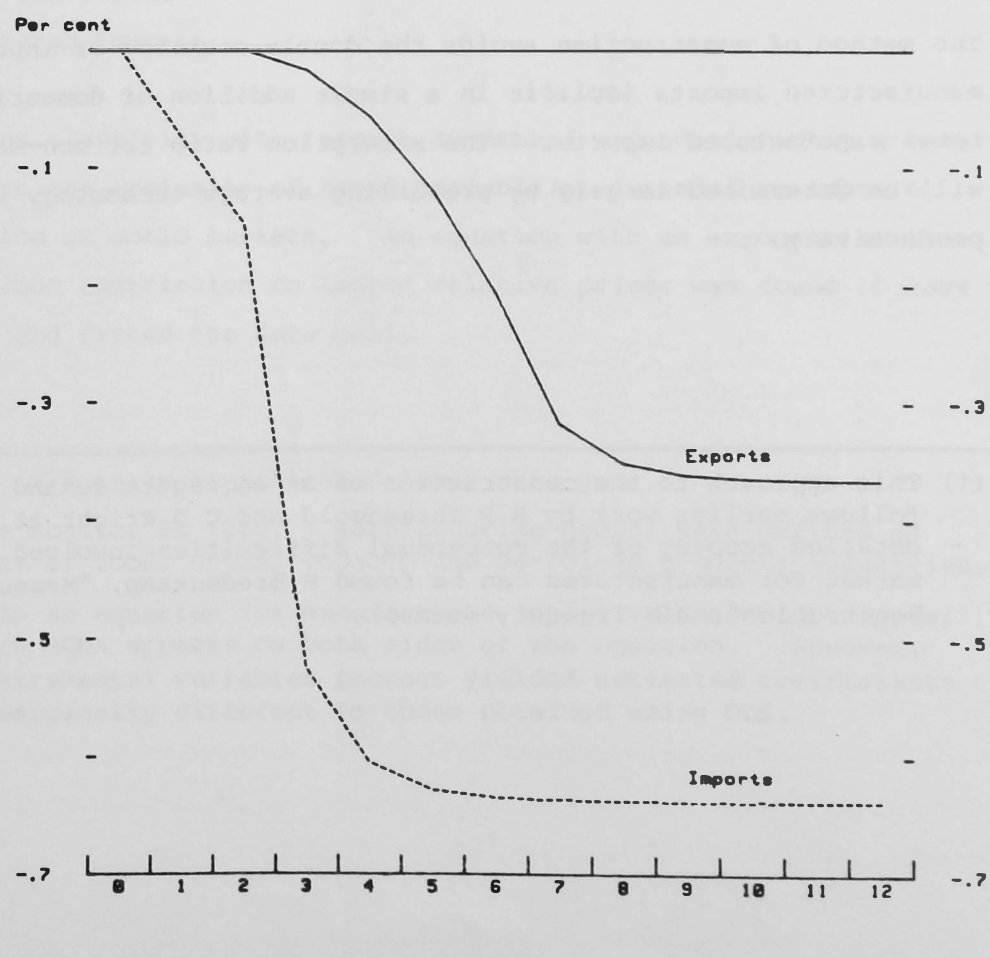


Chart 2

Cumulative response of trade volumes to a 1% change in relative prices



MAND = (a) Inputs of domestic non-manufactures to manufacturing sector, plus

(b) Inputs of imported non-manufactures to manufacturing sector, plus

(c) Inputs of imported manufactures to manufacturing sector, plus

(d) Value added in domestic manufacturing, plus

(e) Imports of manufactures to final demand, plus

(f) Inputs of imported manufactures to non-manufacturing sector.

(a) to (d) sum to total domestic output (net of direct intra-sector transactions), while (c) plus (e) and (f) equal total manufactured imports. The aggregate MAND (1) is intended to approximate a total flow of manufactures to UK final expenditure and intermediate non-manufacturing demand at a given time: it is assumed that this ex post supply reflects an ex ante demand for manufactures which may be met either from domestic output or from imports. Quarterly data is available for (d) and (c + e + f), domestic value added and total manufactured imports respectively, and MAND is constructed assuming a constant ratio of non-manufacturing inputs to domestic value added, γ:

$$MAND = (1 + \gamma)\, d + (c + e + f)$$

$$= \frac{(a+b)}{d}$$

The method of construction avoids the double-counting of inputs of manufactured imports implicit in a simple addition of domestic output and total manufactured imports. The absorption ratio for non-manufactures, γ, will be determined largely by prevailing average technology and productivity.

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(1) This approach to the construction of an aggregate demand for manufactures follows earlier work by A R Threadgold and C B Wright at the Bank. A detailed account of the conceptual difficulties involved in defining a total market for manufactures can be found H Bredenkamp, "Measuring Import Penetration", H M Treasury (mimeo).

Using 1974 input-output data (1), calculation of γ proceeded as follows:

£ million 1974

Total inputs to domestic manufacturing (2)		57.2
Of which:	Intra-sector transactions	18.9
	Inputs of imported manufactures	6.7
	Inputs of imported non-manufactures	0.7
	Inputs of domestic non-manufactures	11.1
	Profits	3.2
	Wages	15.7
	(Taxes less subsidies	0.7)

$$\gamma = \frac{0.7 + 11.1}{3.2 + 15.7} = 0.62$$

A UK demand for manufactures, MAND, was therefore proxied as (3):

MAND = 1.62 (MPRO - MPRX) + MGMA

MPRO = Total manufacturing value added

MPRX = Value added in the food, drink, tobacco and petroleum products manufacturing industries

MGMA = Total manufactured imports

The estimated long-run elasticity with respect to demand was consistently greater than unity, even after the inclusion of trend variable(s) intended to capture the growing integration of world markets. An equation with an exponential time trend and a linear Almon restriction on lagged relative prices was found to have plausible properties and fitted the data well.

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(1) Data relating to 1979 is to be published later this year.

(2) Source: Business Monitor PA 1004. Manufacturing sector here defined as rows 24-91, ie net of food, drink, tobacco and petroleum products industries.

(3) The use of MAND in an equation for manufactured import volumes might appear problematic, since MGMA appears on both sides of the equation. However, the use of an instrumental variables package yielded estimated coefficients which were only marginally different to those obtained using OLS.

There was no evidence of a short term overshooting of import volumes in response to a change in MAND, possibly because the initial surge in buffer imports of capital and consumer goods is indistinguishable from a subsequent substitution within the total manufacturing category towards imports of intermediate goods which complement increasing domestic production.

$$\ln MGMA_t = \underset{(8.6)}{-\,6.196} + \underset{(4.3)}{0.290}\ \ln MGMA_{t-1} + \underset{(10.5)}{1.178}\ \ln MAND_t + \underset{(8.3)}{0.009}\ TIME$$

$$+ \sum_{i=1}^{3} b_i \ \ln\,(UMGM.(1 + TAR)/PIMO)_{t-i}$$

$b_1 = -\ 0.075$ $\qquad$ $b_3 = -\ 0.226$

$b_2 = -\ 0.151$

$\sum_{i=1}^{3} b = -\ 0.452$ (7.2)

SEE = 0.0278 $\qquad$ $\bar{R}^2 = 0.995$ $\qquad$ 1967 (I) - 1981 (IV)

LM test for residual autocorrelation: $X^2_{(5)} = 6.6$

The manufactured import unit value index is compiled on a tariff-exclusive basis, and in order to reflect selling prices, it has been multiplied by (1 + TAR). The UVI for manufactured imports and domestic wholesale prices are both measured exclusive of VAT, although it is levied on goods in both categories: it is assumed that changes in VAT do not affect relative import prices.

The long-run elasticity of manufactured import volumes with respect to relative prices is -0.64, with a mean lag of 2.8 quarters (the cumulative response is shown in Chart 2). The price elasticity is greater than that for exports, but relative import prices typically vary by a lesser amount (Chart 3). The long-run demand elasticity for imports is 1.66, with a mean lag of 0.3 quarters. The time trend contributes roughly 5% per annum: the combination of the high demand elasticity and the trend effect reflect the rapid growth in import penetration over the estimation period as a whole. The inclusion of the trend again results in an unambiguous improvement in the goodness of fit, but given the collinearity of MAND and TIME over most of the estimation period an interpretation of the latter variable's contribution to MGMA growth as reflecting solely a reduction in non-tariff protection, and/or an increased variety of goods available for consumption (Barker, 1970) is perhaps best advanced with caution.

Chart 3

Price Competitiveness

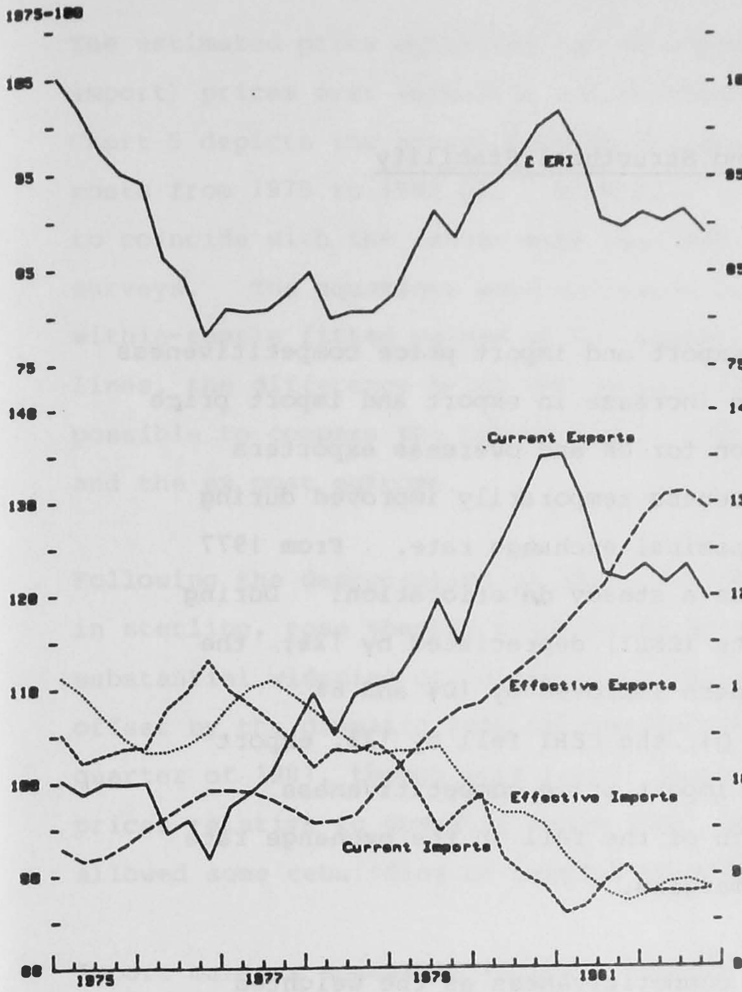
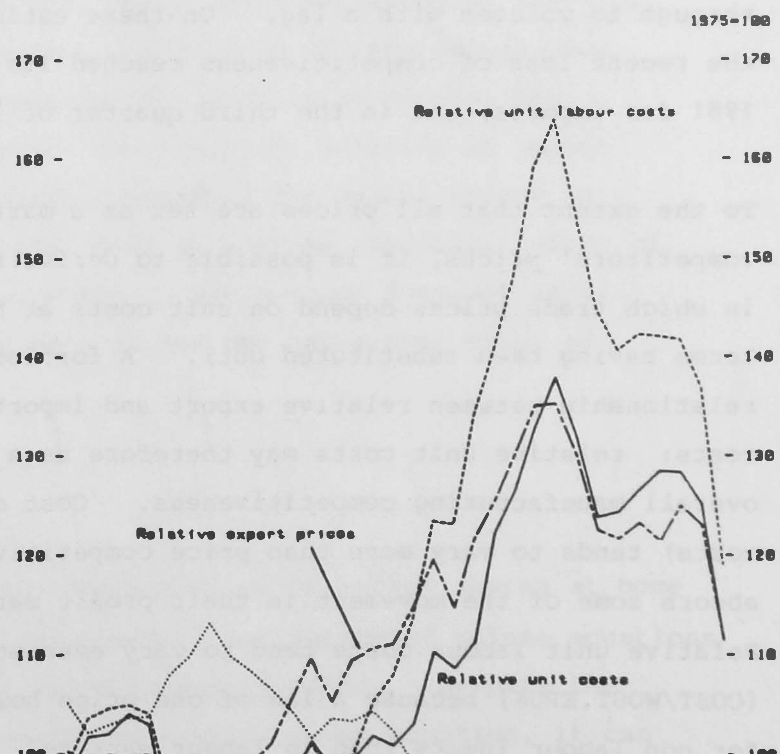


Chart 4

Cost & price competitiveness



5

Tracking Performance and Structural Stability

Price competitiveness and margins

Chart 3 illustrates recent movements in export and import price competitiveness (UXGM/WPIM.ERUK; UMGM (1+TAR)/PIMO): an increase in export and import price competitiveness represents a deterioration for UK and overseas exporters respectively. The UK's price competitiveness temporarily improved during 1976, following the depreciation of the nominal exchange rate. From 1977 until the first quarter of 1981, there was a steady deterioration. During 1981, the sterling effective exchange rate (£ERI) depreciated by 12%; the UK's export and import price competitiveness improved by 10% and 6% respectively. Between 1982 Q3 and 1983 Q1, the £ERI fell by 12%, export price competitiveness improved by 11%. Import price competitiveness improved by only 4% over this period, much of the fall in the exchange rate apparently being absorbed in importers' margins.

It is useful to define "effective" price competitiveness as the weighted average of current and past movements in price competitiveness embodied in the equations presented above, since changes in price competitiveness feed through to volumes with a lag. On these estimates, the adverse impact of the recent loss of competitiveness reached its peak in the fourth quarter of 1981 for imports, and in the third quarter of 1982 for exports.

To the extent that all prices are set as a mark up on unit costs modified by competitors' prices, it is possible to derive reduced form price equations in which trade prices depend on unit costs at home and abroad (the price terms having been substituted out). A fortiori, there is a reduced form relationship between relative export and import prices and relative unit costs: relative unit costs may therefore be a useful summary indicator of overall manufacturing competitiveness. Cost competitiveness (relative unit costs) tends to vary more than price competitiveness because companies absorb some of the movement in their profit margins (see Chart 4). Relative unit labour costs tend to vary even more than relative unit costs [COST/WOST.ERUK] because a law of one price holds more closely in markets for non labour inputs than in labour markets.

The estimated price equations can be expressed as a mark up of (export and import) prices over (domestic and overseas) unit costs (UXGM/COST, WMGM/WOST.ERUK). Chart 5 depicts the actual mark up on manufactured export and import unit costs from 1975 to 1983 Q1. Movements in this measure of the profit margin to coincide with the rather more qualitative evidence supplied by CBI surveys. The equations were estimated up to the end of 1981, and the within-sample fitted values of the equations are shown by the dashed lines, the difference being the dynamic residual (1). After 1981, it is possible to compare the out-of-sample (dynamic) forecasts of the equations and the ex post outcome.

Following the depreciation in 1976, overseas competitors' prices, expressed in sterling, rose sharply relative to UK exporters' unit costs, allowing a substantial widening of UK exporters' margins. This increase was more than offset by the dramatic loss of competitiveness between 1979 and the first quarter of 1981, though more recent favourable movements in overseas competitors' prices relative to domestic costs (both expressed in sterling terms) have allowed some rebuilding of margins to occur.

Import margins appear to follow a broadly similar, but inverted, pattern over much of the period: margins were squeezed during 1976 and then increased dramatically between 1977 and 1980, reflecting an increase in competing domestic prices relative to overseas unit costs (both expressed in sterling terms). During 1981, and more recently, the mark up on imports has been squeezed as the exchange rate has depreciated: to a large extent, the estimated equation has failed to capture the resultant weakness of import prices over the period. The mean dynamic residual for import prices is -3.0% over the forecast period, compared with an average (absolute) error of 1.0% for the period 1975-1982 Q4 as a whole. The average forecast error for export prices is -2.0%, compared with an average (absolute) error of 0.7% over the longer period.

Market shares and trade volumes

Chart 6 illustrates recent changes in constant-price UK market shares at home and abroad, together with the paths suggested by the estimated volume equations on the assumption of constant (1975) price competitiveness. Despite the favourable trend identified in the estimated export volume equation, it can

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(1) The dynamic residuals are obtained by using predicted values rather than actual values of the lagged dependent variable.

Chart 5

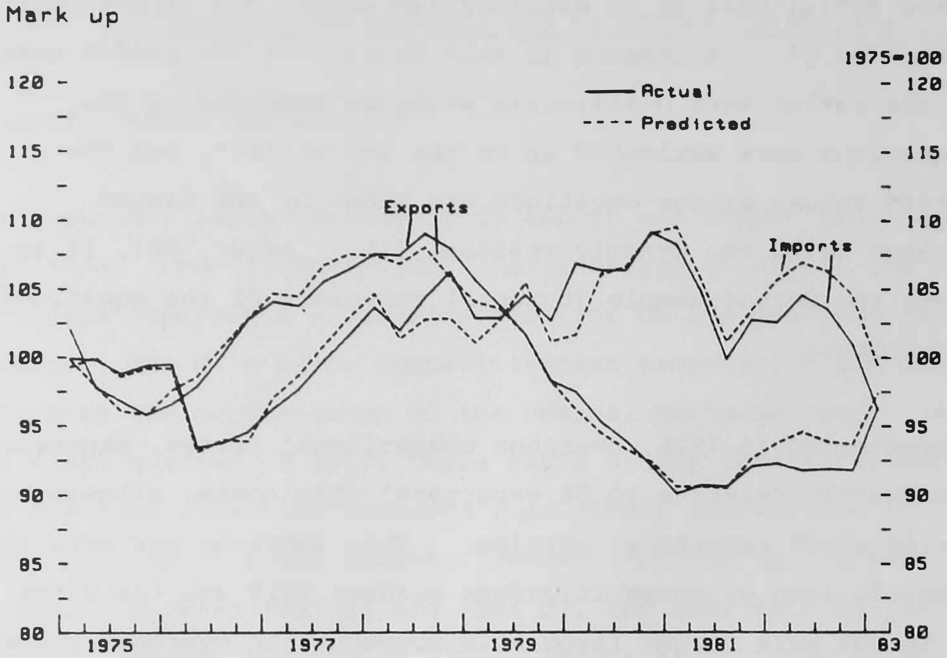
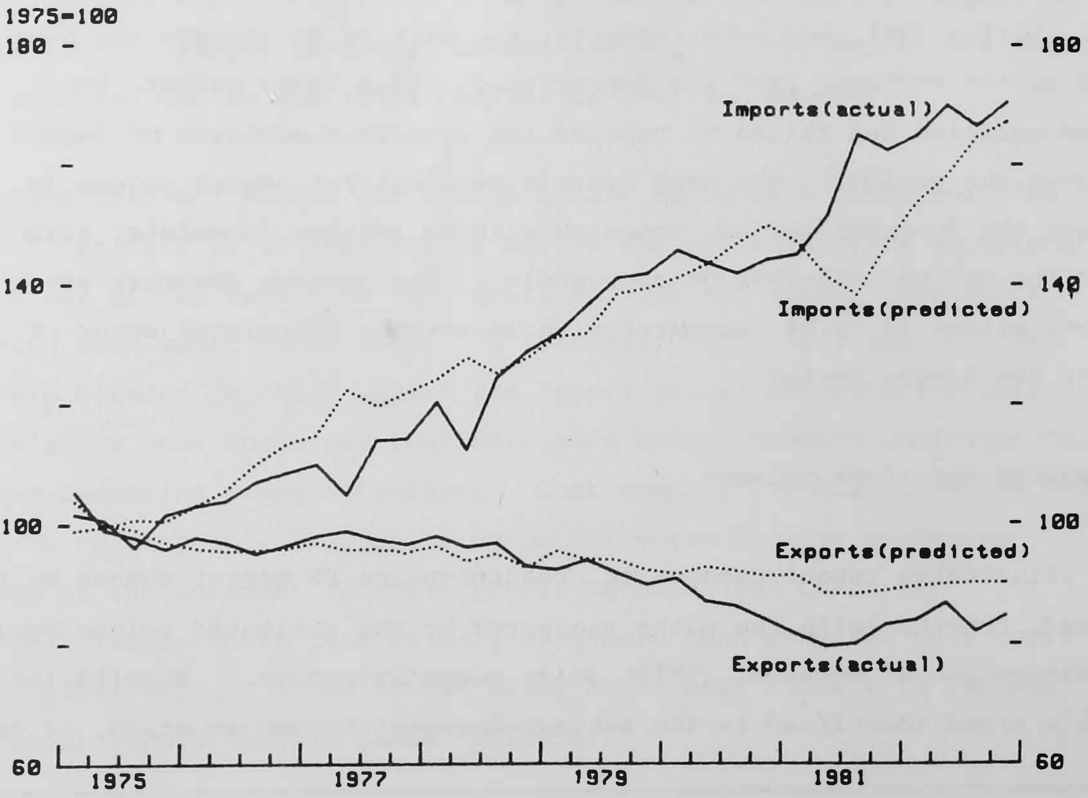


Chart 6

Constant price market shares at home and abroad: outturn together with values predicted using constant (1975) competitiveness



be seen that the share of UK manufactured exports in weighted total world trade in manufactures has continued to fall in recent years, augmented since 1979 by worsened price competitiveness. The loss in market share at home has been more dramatic, with import penetration rising by some 70% between 1975 and 1982.

The dynamic performance of the volume equations is illustrated in Chart 7. In order to obtain comparable dynamic residuals for exports and imports, it was necessary to estimate a linking equation relating the proxy for total demand for manufactures, MAND, to the components of final expenditure and the real price of manufactures. Predicted values of MAND were then used in a dynamic simulation for import volumes.

Trade volumes are likely to be particularly sensitive to changes in the levels of stocks held by distributors and producers, and in estimating the linking equation, total stockbuilding (Δ ln KIIT) and residual final expenditure (CIGX) were included as separate variables. A "real" price for manufactured goods (PMF) was constructed as a base-weighted arithmetic average of the UVIs for import prices and domestic output divided by the deflator for total final expenditure:

$$\ln MAND_t = \underset{(5.7)}{-\,0.420} + \underset{(7.9)}{0.577} \ln MAND_{t-1} + \underset{(7.1)}{1.935}\, \Delta_t \ln KIIT + \underset{(6.5)}{0.948} \ln CIGX_t$$

$$\quad - \underset{(3.4)}{0.525} \ln CIGX_{t-1} - \underset{(1.7)}{0.235} \ln PMF_{t-2}$$

SEE = 0.0179 $\bar{R}^2 = 0.973$ 1967 (I) - 1981 (IV)

LM test for residual autocorrelation: $\chi^2_{(5)} = 4.6$

The restriction that the long-run elasticity of MAND with respect to total final expenditures (excluding stockbuilding) be unity was accepted by the data. The long-run coefficient on the real price of manufactures is 0.56, the impact coefficient being marginally significant at the 90% confidence level.

Out-of-sample dynamic forecasts of trade volumes for the period 1982 Q1 to Q4 can be compared with the outturn. The import volume equation shows a tendency to overpredict, with an average dynamic residual of -4.9% in 1982, while the equation for export volumes underpredicts, the average dynamic error being 4.3%. The forecast errors compare with dynamic average (absolute) errors for the period 1975-1982 of 3.4% for imports and 2.0% for exports.

Chart 7

Trade volumes

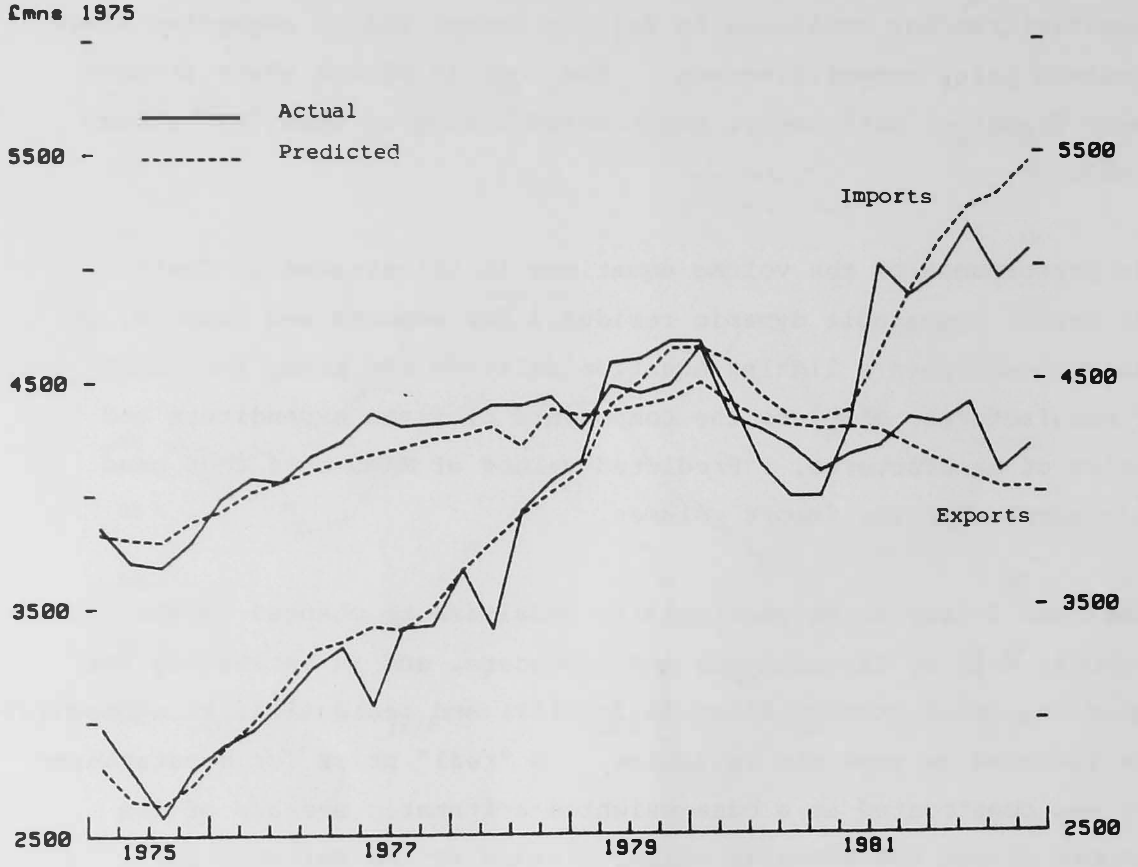
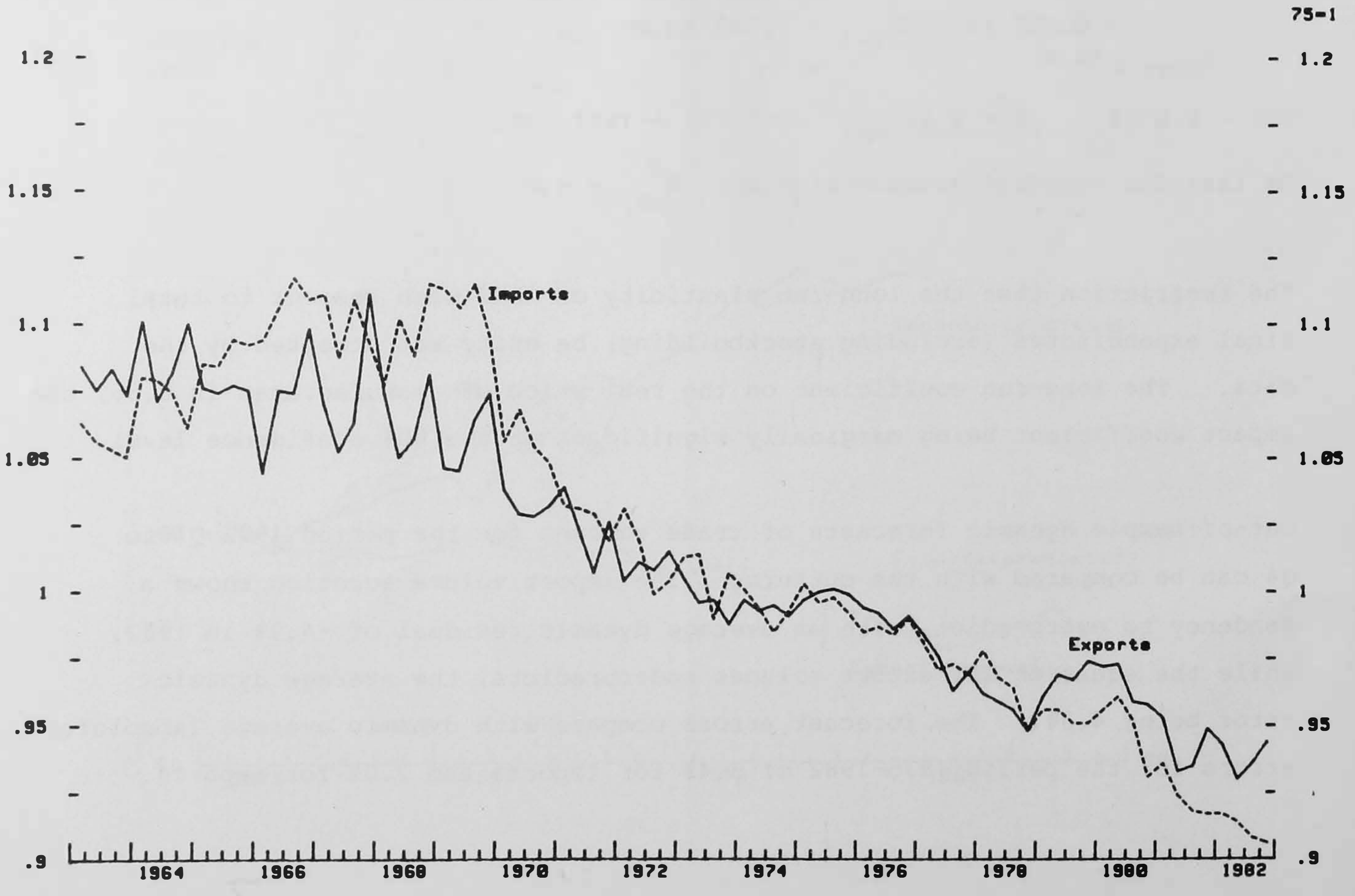


Chart 8

AVI/UVI Ratios for Manufactured Exports and Imports



Structural stability

The price and volume equations were tested for stability by splitting the estimation period into two equal sub-periods at 1974 Q3. The results are summarised in Table 1.

While three of the four equations pass the Chow test for parameter stability, in several instances the various full-sample estimated elasticities lie outside the range of the sub-sample estimates, suggesting that individual parameters are poorly determined over time. To some extent, such indeterminacy mirrors the results of previous Bank research in this area, and is in line with the results reported for export volumes in Brooks (1981).

As the integration of world markets has increased, we might have expected the importance accorded to competing domestic prices by overseas suppliers to have fallen. Subject to the qualification above, for UK importers this does not appear to have occurred, with UK producer prices growing in significance as a determinant of import prices and some evidence of an increased sensitivity of import volumes to changes in relative prices. To some extent this may be explained by an increased product homogeneity within individual markets leading to greater compliance with a law-of-one-price: this would offset the influence of growing market penetration.

TABLE 1: Stability of the estimated coefficients

All variables are in logs. The data set is split at 1974 (III): $\rho 1$ = 1967 (I) - 1974 (II)*, $\rho 2$ = 1974 (III) - 1981 (IV). The F-statistic refers to the Chow test for parameter stability

Dependent variable	Independent variables	Coefficients (t)			Long-run elasticities		
		Full sample	$\rho 1$	$\rho 2$	Full sample	$\rho 1$	$\rho 2$
UXGM	CNST	-0.78	0.07	-1.00	-	-	-
		(3.5)	(0.2)	(3.6)			
	$UXGM_{t-1}$	0.62	0.39	0.60	-	-	-
		(15.4)	(3.6)	(9.8)			
	$WPIM.ERUK_t$	0.12	0.21	0.12	0.32	0.34	0.30
		(6.8)	(3.7)	(4.4)			
	$COST_{t-1}$	0.27	0.34	0.29	0.71	0.56	0.73
		(6.2)	(3.8)	(5.2)			
F = 2.22	POD_{t-1}	0.17	0.04	0.21	0.45	0.07	0.53
		(3.4)	(0.4)	(3.9)			
	Residual sum of squares	0.005909	0.003131	0.001703			
($F^{0.95}_{5,50}$ = 2.41)	$\bar{R}^2$	0.9996	0.9948	0.9991			
UMGM	CNST	0.02	-0.02	0.02	-	-	-
		(3.4)	(1.9)	(2.7)			
	$UMGM_{t-1}$	0.51	0.36	0.45	-	-	-
		(9.8)	(3.3)	(6.5)			
F = 1.90	$PIMO_{t-1}$	0.10	0.10	0.11	0.20	0.16	0.20
		(11.3)	(1.1)	(4.0)			
($F^{0.95}_{4,51}$ = 2.57)	$WOST.ERUK_t$	0.39	0.47	0.43	0.80	0.73	0.78
		(12.5)	(7.4)	(8.8)			
	Residual sum of squares	0.011607	0.005916	0.004183			
	$\bar{R}^2$	0.9992	0.9925	0.9970			
XGMA	CNST	3.71	5.5	4.1	-	-	-
		(6.1)	(3.6)	(4.6)			
F = 1.21	$XGMA_{t-1}$	0.30	0.10	0.32	-	-	-
		(2.8)	(0.5)	(2.4)			
	$TWIP_t$	0.70	0.90	0.68	1.00	1.00	1.00
		(6.5)	(4.9)	(5.0)			
($F^{0.95}_{5,50}$ = 2.41)	$XCOMP^{\emptyset}$	-0.26	-0.50	-0.37	-0.37	-0.56	-0.54
		(4.3)	(1.9)	(3.1)			
	SPEC	0.18	0.08	0.41	0.26	0.09	0.60
		(4.6)	(0.9)	(2.0)			
	Residual sum of squares	0.031139	0.017117	0.010653			
	$\bar{R}^2$	0.9852	0.9667	0.8526			
MGMA	CNST	-6.20	-2.45	-7.72	-	-	-
		(8.6)	(1.7)	(7.4)			
	$MGMA_{t-1}$	0.29	0.59	0.18	-	-	-
		(4.3)	(4.5)	(2.35)			
F = 2.59	$MAND_t$	1.18	0.55	1.43	1.66	1.34	1.74
		(10.5)	(2.7)	(10.0)			
	$MCOMP^{\emptyset}$	-0.45	-0.30	-0.68	-0.63	-0.73	-0.83
		(7.2)	(3.2)	(4.3)			
($F^{0.95}_{5,50}$ = 2.41)	TIME	0.01	0.01	0.01	6% pa	10% pa	5% pa
		(8.4)	(8.4)	(5.1)			
	Residual sum of squares	0.042497	0.015412	0.018331			
	$\bar{R}^2$	0.9948	0.9913	0.9788			

* The data period for UMGM starts in 1967 (II)

$\emptyset$ The coefficients on XCOMP and MCOMP are the total coefficients on the respective lagged relative price terms

6

Summary and conclusion: next stages in the research programme

The paper has sought to develop and estimate the parameters of a model of the UK traded manufactures sector. The reported price equations should be seen as incorporating the supply decision, while the volume equations can be interpreted directly as demand schedules.

Several refinements to the basic structural model may repay further study. It may be worth investigating, for example, the implicit behavioural equation for domestic output embodied in the equations for import volumes and the total demand for manufactures: given predicted demand and imports, home production is determined as a residual, and the model thus allows for the simultaneous determination of output and imports as a function of competitiveness, total market size and a trend. The partial adjustment profile for the response of import volumes to a change in demand may prove to result in a short-run overshooting of domestic supply, which may be thought implausible. Possible solutions might involve the inclusion of lagged domestic output in the general form for import volumes, or the estimation of two separate equations relating the final expenditure categories directly to imports and output, with a total demand for manufactures then obtained as the resultant aggregate.

It may also be worthwhile re-estimating the equations using the more recent data for 1982 (and early 1983 in some instances) in an attempt to improve tracking performance over the recession. To the extent that the poor performance of the import volume equation has been correlated with the stock cycle, there is a further argument for paying closer attention to the links between ex ante national income and ex post demand for manufactures. In the case of import prices, future research may involve the construction of more accurate proxies for suppliers' non-labour input costs, using appropriately-weighted indices of industrial material prices for each country.

The inclusion of trend effects in the trade volume equations may cause problems when using the model estimated above for forecasting purposes. In addition to the need for projections of the usual exogenous variables, an explicit judgement concerning the likelihood of continued trade liberalisation becomes necessary. To the extent that overseas protection (for example) has increased in recent years (1), it may be thought desirable to restrain the trend growth of export volumes.

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(1) See, for example, the topic discussed at the 1983 International Economics Study Group conference: "Protectionist threats to the Multilateral Trading System".

The properties of the model presented above are difficult to analyse in the absence of full macroeconomic simulation: nonetheless, an impression of the likely sensitivity of the estimated (OTS) manufacturing balance to movement in the nominal exchange rate (for example) can be gained by focussing on each equation in turn and considering the likely direction of potential feedback effects. Taking the import price equation first, a maintained step 10% increase in overseas prices and costs (in sterling terms) will, in the long run, result in a 7.9% increase in the sterling price of manufactured imports as measured by the UVI: the associated deflator will increase by roughly 7.4% (see Annex 1). However, this neglects the likelihood of a further rise in import prices induced by higher competing domestic prices. Despite the results reported in Coutts, Godley and Nordhaus (1978) it seems unlikely that domestic producers will not take advantage of the increase in competing import prices to raise their own prices, and depending on the extent to which this occurs (and the extent to which higher prices of imported consumer goods serve directly to increase wage costs) the increase in sterling import prices will exceed that implied by the coefficient on overseas costs considered in isolation. The long-run change in import price competitiveness will be less than 7.9%, since the induced change in the domestic price level will affect numerator and denominator to a different extent: import volumes will (holding demand constant) therefore fall by less than 5.1% (7.9% x 0.64). The value of imported manufactures will rise, by at least 1.9%.

Export prices will rise by 3.2% in direct response to the maintained increase of 10% in competing overseas prices, (the relevant deflator is likely to rise by some 2.9%) and will be further augmented by any increase in domestic prices and wage costs induced by more expensive imported and domestically-produced consumer goods. Export price competitiveness will therefore improve by less than 6.2% (1.032/1.100), and export volumes by less than 2.3% (6.2% x 0.37).

The increased volume of exports will in turn increase final expenditures and the total demand for manufactures; the associated reduction in excess capacity (together with any Phillips-curve effect) will serve to strengthen export prices (and domestic prices in general), causing a further erosion of the initial gain to competitiveness. The subsequent induced increase in import volumes will further diminish the initial improvement in relative trade volume, though to a lesser extent as the increase in export volumes is offset by worsened competitiveness. The long-run elasticity of current-price exports with respect to increased sterling overseas prices remains positive, but it seems likely that the unambiguous improvement in the manufactures account (1) implied by the equations considered in isolation will be rapidly eroded by subsequent developments elsewhere in the economy. It is perhaps worth noting that the model suggests that any long-term benefits resulting from depreciation are likely to reflect favourable movements in export prices rather than increased export volumes, with corresponding implications for output and employment.

As noted at Section 2 above, an alternative approach to the estimation of structural equations would be to specify reduced forms for prices and volumes, relating each dependent variable to measures of production costs, excess capacity, competing prices and potential demand. It is hoped that a second Technical Paper will report the results of simulating both structural and reduced forms on the Bank's short-term macroeconomic model: if the structure is correctly specified, the overall simulation properties in both approaches will be identical, providing a useful check on the validity of the results reported above.

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(1) Starting from a position of trade balance.

Annex 1

UVI-AVI linking equations

The behavioural price equations predict unit value indices (1975 base weighted). In order to simulate a current-price trade balance, linking equations are needed to predict deflators which can be used subsequently to translate predicted volumes into values. Although these UVI/AVI linking equations are perhaps of little intrinsic interest, they may be of some importance in assessing the simulation properties of a given model.

As long as prices within the relevant trade category do not grow uniformly, the AVI will grow less rapidly than the corresponding UVI, reflecting substitution towards those goods whose prices are rising less rapidly (see Chart 8). At the macro level, changes in price competitiveness have been found to have little immediate effect on trade volumes, and the current value of trade tends to increase in proportion to an increase in trade prices. In the longer term, however, the adverse accounting impact of (say) increased import prices is offset, to an extent, by a favourable movement in import volumes in response to the improvement in competitiveness. This J-curve effect may be mirrored in a sense at a micro level in the Laspeyres/Paasche index divergence.

Subject to the assumption of a range of price increases underlying a given change in the aggregate unit value index, then, and with the qualification that substitution in demand can result in movement in the deflator with no corresponding change in the UVI (1), the J-curve effect implies that the initial impact on the AVI of a change in the UVI declines monotonically to some long run (cumulative) response as buyers become fully accustomed to the new set of relative prices.

The preferred equations were chosen on the grounds that they appear to fit the data well, they do not suffer from excessive residual autocorrelation, and the cumulative responses to step changes in the UVIs are plausible in terms of the hypothesis sketched above.

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(1) A possibility which is confined to the disturbance term in the estimated equations.

$$\ln PXGM_t = -\underset{(1.7)}{0.005} + \underset{(13.8)}{0.959} \ln UXGM_t - \underset{(4.5)}{0.594} \ln UXGM_{t-1}$$

$$+ \underset{(5.1)}{0.617} \ln PXGM_{t-1}$$

$\bar{R}^2 = 0.9996$ 1971 (I) - 1981 (IV)

LM test for residual autocorrelation: $X^2_{(5)} = 6.1$

$$\ln PMGM_t = -\underset{(2.3)}{0.007} + \underset{(17.6)}{0.998} \ln UMGM_t - \underset{(2.6)}{0.433} \ln UMGM_{t-1} - \underset{(2.6)}{0.395} \ln UMGM_{t-2}$$

$$+ \underset{(2.7)}{0.417} \ln PMGM_{t-1} + \underset{(2.6)}{0.401} \ln PMGM_{t-2}$$

$\bar{R}^2 = 0.9996$ 1971 (I) - 1981 (IV)

LM test for residual autocorrelation: $X^2_{(5)} = 10.6$

In the case of the export deflator, the impact coefficient of 0.959 on the unit value index falls by a negligible amount to a long-run coefficient of 0.954 within eighteen months. The equation linking the import AVI to its UVI displays an impact coefficient of almost unity (0.998), declining monotonically to a long-run coefficient of 0.939 after more than five years. It is not clear why the speeds of adjustment should vary to such an extent.

ANNEX II

Nested tests for selection of restricted form equations

XGMA

N = 60

		RSS	K	LM test for 5th order residual autocorrelation $X^2_{(5)}$
HM	Constant; two lagged dependent variables; nine lagged relative price terms; two lagged demand terms; trend variable:	0.028075	15	15.1
	Exclusion of second lagged dependent variable, lagged demand and lags zero, one, two and eight on relative prices:	0.029252	9	6.9
	Restriction of long-run elasticity of demand to unity:	0.029255	8	7.0
HF	Linear Almon profile on lags three to seven of relative price term (end point constraint at near end):	0.031139	4	9.5

MGMA

N = 60

		RSS	K	LM test for 5th order residual autocorrelation $X^2_{(5)}$
HM	Constant; two lagged dependent variables; three lagged demand terms; nine lagged relative price terms; time trend:	0.036562	16	6.6
	Exclusion of second lagged dependent variable, lags one and two of demand, lags zero and four to eight of relative prices:	0.042391	7	6.5
HF	Linear Almon profile on lags one to three of relative prices (end point constraint at near end):	0.042497	5	6.6

UXGM

N = 60

		RSS	K	LM test for 5th order residual autocorrelation $\chi^2_{(5)}$
HM	Constant; two lagged dependent variables; two lagged cost terms; two lagged competing price terms; two lagged capacity utilisation terms:	0.005657	9	4.4
	Exclusion of second lagged dependent variable, lag zero of costs and lag one of competing prices:	0.005901	6	2.8
HF	Exclusion of lag one of capacity utilisation	0.005909	5	3.1

UMGM

N = 59

		RSS	K	LM test for 5th order residual autocorrelation $\chi^2_{(5)}$
HM	Constant; two lagged dependent variables; two lagged cost terms; two lagged competing price terms; two lagged capacity utilisation terms (2SLS):	0.011129	9	11.2
	Exclusion of lag zero of competing prices (OLS):	0.010654*	8	9.4
	Exclusion of second lagged dependent variable and capacity utilisation terms:	0.011708	5	8.1
HF	Exclusion of lag one of cost term:	0.011607	4	6.6

* The reduction in the residual sum of squares despite the exclusion of an explanatory variable reflects the loss of efficiency involved in using 2SLS to estimate HM.

Index of variables*

CIGX	=	Aggregate non-stockbuilding final expenditure (volume)
COST	=	Domestic unit costs, cost per unit of output (£ million)
ECMM	=	Total earnings in manufacturing (£ million)
ECMM/HMF	=	Earnings per man-hour (£ million)
EER	=	Sterling effective exchange rate (1975=100)
ERUK	=	UK exchange rate against US$ (1975=100)
HMF	=	Actual average hours worked in manufacturing industry
HMFT	=	Total hours worked in manufacturing industry
KIIT	=	Total stocks (volume)
LEMF	=	Employment in manufacturing industry
MAND	=	Domestic demand for manufactures (volume)
MBIP	=	Wholesale buying in prices, cost per unit of non-labour input (1975=100)
MGMA	=	Manufactured import volumes
MPRO	=	Total net manufacturing production (volume)
MPRO/HMFT	=	Productivity
MPRO/LEMF	=	Labour productivity, real output per man-hour
MPRX	=	Net production of food, drink, tobacco and petroleum product industries (volume)
NORD	=	Domestic cyclical variations in productivity
NORW	=	Overseas cyclical variations in productivity
PIMO	=	UK wholesale prices (excluding food, drink, tobacco and petroleum products)
PFO$	=	World dollar price of oil
PMF	=	Real price of manufactures
PMGM	=	Price deflator for imports of manufactured goods, AVI
POD	=	Capacity utilisation in UK
POW	=	Capacity utilisation overseas
PXGM	=	Price deflator for exports of manufactured goods, AVI
SPEC	=	Ratio of OECD manufacturing trade to output (volume)
TAR	=	Tariff rate
TIME	=	Time trend
TWIP	=	UK trade weighted OECD industrial production (volume)
UMGM	=	Manufactured import price, UVI
UNME	=	UN commodity price index for non-ferrous metals
UXGM	=	Manufactured export price, UVI
WPIM.ERUK	=	Overseas wholesale prices in sterling terms
WOST.ERUK	=	Overseas costs per unit of output in sterling terms
XGMA	=	Manufactured export volumes

* Sources as per Bank model manual

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Bank of England Discussion Papers

	Title	Author
1-5, 8 10-14, 16 & 17	*A list of these papers can be found in the December 1981* Bulletin, *or can be obtained from the Bank. These papers are now out of print, but photocopies can be obtained from University Microfilms International (see below).*	
6	'Real' national saving and its sectoral composition	C T Taylor A R Threadgold
7	The direction of causality between the exchange rate, prices and money	C A Enoch
9	The sterling/dollar rate in the floating rate period: the role of money, prices and intervention	I D Saville
15	Influences on the profitability of twenty-two industrial sectors	N P Williams
18	Two studies of commodity price behaviour: Interrelationships between commodity prices Short-run pricing behaviour in commodity markets	 Mrs J L Hedges C A Enoch
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Technical Series

	Title	Author
1	The consumption function in macroeconomic models: a comparative study*	E P Davis
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4	The impact of exchange rate variability on international trade flows	G Justice
5	Trade in manufactures	A C Hotson K L Gardiner

Papers presented to the Panel of Academic Consultants[a]

	Title	Author
8	International monetary arrangements the limits to planning*	P M Oppenheimer
9	Institutions in the financial markets: questions, and some tentative answers*	M V Posner
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15	Factors underlying the recent recession	G D N Worswick Dr A Budd
17	Why do forecasts differ?	Prof M J Artis
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(a) Other papers in this series were not distributed.