Tradable and Non-Tradable Prices in the UK and EC: Measurement and Explanation

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Abstract

A marked divergence in inflation rates between the tradables and non-tradables sectors has been a feature of some EC economies, especially those of Italy, Spain and the UK, since the early 1980s. Sectoral productivity differences, international competitive pressures - perhaps linked to ERM membership, and government demand for non-tradables are possible reasons. Empirical estimates of sectoral price equations are presented for the UK, using especially constructed RPI-based series. Competing import prices, unit labour costs, and input prices are found to be the main determinants of tradable prices. For non-tradables government demand is important. Tests show that tradable prices Granger-cause non-tradable prices in France, Germany and Italy as well as the UK.

Keywords: Tradable and non-tradable prices, international competition.

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Introduction

In the literature on economic development, the positive relationship between the relative price of non-tradables and tradables and income per capita is a well-established stylised fact, see Falvey and Gemmell (1991) and the references therein. In this context models have been used which incorporate differences in production technologies, or explain relative prices in terms of exogenous variables such as factor endowments, population etc - which in turn influence real incomes and non-tradables prices. In their paper, Falvey and Gemmell find that the relative price of services, measured using UN data, is positively related to factor endowments and real trade deficits, but negatively related to population and the size of the labour force.

The literature on sectoral prices in advanced economies is more recent. Alogoskoufis (1990) presents estimates of equations for competitiveness, defined as the relative price of exports to the GDP deflator, and the terms of trade, defined as the ratio of export to import prices. These are in the context of a small structural empirical macromodel of the UK. One of his conclusions is that post-war UK experience has been characterised by output flexibility and wage-price rigidity. Since price sluggishness extends to the traded goods sector, Alogoskoufis notes that the model is observationally equivalent to single-sector Keynesian models. De Gregorio *et al* (1993) provide estimates of the real exchange rate for five major EC countries on annual data from 1970 to 1990.

As these examples show, the focus of most previous empirical work has been on relative, that is, real, prices. In this paper the main aim of the empirical work is to explain nominal prices. The main reason for this emphasis is to try to distinguish more clearly than hitherto external inflationary influences, which can be expected to impinge mainly on tradable prices, from those generated domestically. An important feature of the work is the distinction drawn in estimation between equilibrium sectoral prices and dynamic adjustment. In the UK it is noticeable that there has been a cyclical pattern of two to three years' duration to the differences in goods and services inflation. Part of the explanation for this appears to have been variations in the nominal exchange rate and international competitiveness, which impinge more directly on goods than services prices.

A brief word on terminology. The terms tradables and non-sheltered, and non-tradables and sheltered, may be used synonymously, although for clarity tradable and non-tradable are preferred here. Like the parallel concept of market contestability used in the industrial organisation literature, see for example Baumol *et al* (1982), tradability is essentially a potential concept - is the good or service capable of being traded given market conditions? It is thus conditioned by market structure and characteristics such as selling costs rather than by physical attributes. In principle at least, tradable and non-tradable correspond only broadly to goods and services.

The subject of this paper has a clear economic policy relevance because of the close link, both behavioural and definitional, between the relative price of traded and non-traded goods - the internal terms of trade - and international competitiveness. Although perhaps not a dominating influence, Eichengreen and Wyplosz (1993), it may be no coincidence that those ERM currencies which depreciated in mid-September 1992 had levels of competitiveness which may have concerned the markets, and substantial divergences between inflation rates in the tradable and non-tradable sectors. It is also of interest to see whether pricing behaviour in the UK was affected by ERM membership. The econometric relationships presented in section 3 below present evidence on this.

If divergences in sectoral prices were solely close proxies for international competitiveness they would mainly be of interest for the information which they shed on the inflation process itself. But they have an additional significance in that price-based indicators of international competitiveness can mask the changes in internal relative prices which may be forced on producers of tradable goods and services to maintain market shares. This has three implications. First, it may encourage resources to move out of the production of tradable goods. Second, strong divergences in sectoral inflation rates imply weak behavioural links between the two sectors. This may be symptomatic of nominal rigidities in price setting, which may differ across industries and sectors according to their degree of concentration; see Martin (1992) for a theoretical discussion of this issue. In these circumstances monetary policies which rely heavily on the exchange rate and reducing inflation in the tradable sector may be less effective than more broad based monetary policies. Third, when they originate from the non-tradable sector, changes in relative prices may be indicative of country-specific shocks, an issue examined formally by Bayoumi and Eichengreen (1993) in a single sector model.

For these reasons traditional single sector 'Scandinavian' open economy models, Lindbeck (1979) for example, may give an inadequate description of inflation convergence under a fixed exchange rate. Two-sector models, with a distinct role for non-tradables, help to illuminate theoretical and empirical discussion since they can capture the sluggishness of inflation convergence and the divergences in sectoral prices that have been observed. The theory outlined in this paper is therefore in these terms.

The paper is in five sections. The first presents a simple theoretical two-sector macromodel which aims to show how prices are set in the tradable (goods) and non-tradable (services) sectors. The second section looks at the UK RPI in some detail. Definitional issues are explored and the behaviour of sectoral RPI indices since 1974 is discussed. In the third section estimated equations for traded and non-traded retail prices are presented. The fourth looks briefly at the experience in other EC countries over the past decade, focusing in particular on France, Italy and Spain. In these countries inflation divergences have been, and in the cases of Italy and Spain continue to be, substantial. The final section concludes.

1. A Two-Sector Open-Economy Macroeconomic Model

This section describes a small two-sector macroeconomic model designed to analyse how relative prices, output, the current account and competitiveness respond to a number of shocks, including to productivity and world prices. The model is similar to those presented by Alogoskoufis (1990) and by De Gregorio *et al* (1993) in that it focuses primarily on the short run, with capital implicitly assumed fixed, and on real magnitudes. The production of tradable goods is assumed to take place in a quasi-competitive market, with a single firm acting as price taker and deciding output on the basis of a CES production function which is separable in imported materials (including oil) and labour and capital. Imperfect competition is also assumed in the non-tradables sector, which is comprised of n firms, each producing a differentiated product with identical technology under increasing returns. Firms sell output to consumers and government, and are free to enter and exit the market. In this sector they are assumed to use labour and capital only. Some market imperfection such as cost of adjustment is required to motivate the model since under perfect competition capital and labour would move freely between sectors and relative prices would be determined by tastes and technologies. A single labour market is assumed, in which firms and a union bargain over the real wage, as in the Layard-Nickell-Jackman (1991) model. Wages are therefore equalised in the two sectors, a close approximation to reality in the UK, and are an increasing function of employment.

The model presented below is static, so no explicit account is taken of price and wage setters' expectations. A variety of models have been developed which address this shortcoming, but in a single sector context. The overlapping contracts model of Taylor (1979) is a good example. An important insight of this literature is that monetary policy and the exchange rate regime affect the degree of inflation persistence. For example, Alogoskoufis (1992) presents evidence that the degree of monetary accommodation and inflation persistence tend to be higher under managed floating than under fixed exchange rate regimes such as Bretton Woods. This applies both for world and relative inflation rates. Essentially this arises when either price or wage setters, or both, take account of future prices and wages in their decisions. Where the monetary policy regime is accommodating, decision-makers will build in higher inflation expectations than when it is non-accommodating. Inflation persistence will therefore be higher under an accommodating regime. Thus in an important sense inflation is a monetary phenomena, even where underlying or equilibrium price behaviour is best understood in terms of a cost mark-up model.

The Tradables Sector

Firms in the tradable sector are assumed to be competitive profit maximisers, taking as given output prices p_T, resource input prices p_R in domestic currency terms and the wage rate W. Capital is assumed fixed in the short run, and profit maximisation is achieved by varying labour and inputs so as to equate marginal revenue products with costs. Following Alogoskoufis (1990) a two-tier CES production function separable in inputs and labour and capital is assumed. Thus:

$$Q_T = \left[\lambda \; V_T^{\;-(1-\rho)/\rho} + (1-\lambda) R_T^{\;-(1-\rho)/\rho} \right]^{-\rho/(1-\rho)} \tag{1.1}$$

$$V_T = \left[\delta \, K_T^{-(1-\tau)/\tau} + (1-\delta) L_T^{-(1-\tau)/\tau} \right]^{-\tau/(1-\tau)} \tag{1.2}$$

where Q_T is gross output, V_T is value-added, R_T, K_T and L_T are respectively resource inputs, capital and labour in the tradables sector. The elasticity of substitution between domestic value added and resource inputs, and between capital and labour are denoted by ρ and τ respectively. λ and δ are the distribution parameters.

The conditions for profit maximisation are:

$$\frac{\partial Q_T}{\partial R_T} = (1-\alpha) \left(\frac{Q_T}{R_T} \right)^{\frac{1}{\rho}} = \frac{P_R}{P_T} \tag{1.3}$$

and

$$\frac{\partial Q_T}{\partial L_T} = \frac{\partial Q_T}{\partial V_T} \cdot \frac{\partial V_T}{\partial L_T} = \lambda \left(\frac{Q_T}{V_T} \right)^{\frac{1}{\rho}} . \; (1-\delta) \left(\frac{V_T}{L_T} \right)^{\frac{1}{\tau}} \tag{1.4}$$

$$= \frac{W}{P_T}$$

since labour receives its marginal product.

From (1.3) and (1.4) the demand for resource inputs and labour can be derived. Taking natural logarithms and using Taylor expansions gives:

$$r_T \approx r_{OT} + q_T - \rho (p_R - p_T) \tag{1.5}$$

$$l_T \approx l_{OT} - \tau (w - p_T) + (\tau/\rho) \; (q_T - v_T) + v_T \tag{1.6}$$

Thus demand for resource inputs is a positive function of gross output in the tradable sector and a negative function of real input prices. Labour demand is a negative function of the real own product wage, a positive function of value-added. Changes in neutral technical progress, a_T, can be thought of as being incorporated in l_{oT}. Thus an increase in a_T raises the marginal revenue product and hence the demand for labour.

The output supply function for tradables is obtained by substituting the factor demand equations (1.5) and (1.6) into (1.1) and (1.2) to give:

$$v_T = v_{oT} + k_T - \frac{\Pi_2 \tau}{1-\Pi_2}(w-p_T) - \frac{(1-\Pi_1)\Pi_2 \tau}{\Pi_1 (1-\Pi_2)}(p_R-p_T) \tag{1.7}$$

where Π_1 and Π_2 are the shares of domestic value added in gross output and of labour in value added respectively, and v_{oT} is a function of l_{oT} and the other parameters. Output supplied is a positive function of the capital stock, exogenous productivity and given world prices of competing products, and a negative function of the sectoral real wage and input prices. The relationship between p_R and p_T can be written as:

$$p_T = \Pi_1 \ p_{VT} + (1-\Pi_1) \ p_R \tag{1.8}$$

where p_{VT} is the price of value added in the tradables sector.

The Non-Tradables Sector

The non-tradables sector is more straightforward. A single representative consumer maximises utility by allocating consumption between tradables and non-tradables subject to the intertemporal budget constraint. Government demand is assumed to be met by the non-tradable sector. Supply is met by imperfectly competitive firms using identical increasing returns Cobb-Douglas technology.

The production function for each of the firms producing the i differentiated products in the non-tradables sector is:

$$V_N(i) = a_N(L_N(i) - F), \quad L_N(i) \geq F \tag{1.9}$$

where F is the fixed amount of labour required to start production. (This specification explains why, with freedom of entry and exit, there is not instantaneous adjustment in the non-tradables sector.)

In this sector supply (value added) equals demand since there are no resource inputs. Firms set prices as a mark-up over marginal costs. For the ith good

$$P_N(i) = \frac{\theta}{\theta - 1} \cdot \frac{W}{a_N} \tag{1.10}$$

where θ is the parameter of the utility function which the consumer optimises over the i non-tradable products. Thus the nominal wage determines the price of non-tradables.

Equilibrium private consumption of non-tradables is obtained by substituting prices into the demand function. Government demand is distributed equally across all i firms, and is assumed to cover marginal costs only. Since profits are therefore equal to sales to the private sector times the mark-up over variable costs, setting profits equal to zero gives the equilibrium number of firms in the sector. Total output of non-tradables is then given by:

$$V_N = \phi I \cdot \frac{\theta - 1}{\theta} \cdot \frac{a_N}{W} + g \tag{1.11}$$

where ϕ is the proportion of total consumers spending I which is on non-tradables and g is total government spending.[1]

Thus tastes and the relative price of tradable and non-tradable are assumed to enter via ϕ. Sectoral productivity, wages and government demand are the other determinants of non-tradable output.

The Labour Market

In this model the labour market is central to the evolution of the economy since wages, sectoral productivity and resource prices determine the relative price of tradables and non-tradables, output in the tradable sector, and hence sectoral shares of output.

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(1) To see how equation (1.11) is derived note that equilibrium private consumption of good i is

$$C_N(i) = \phi . \frac{P_T}{P_N} . \frac{\theta-1}{\theta} . \frac{a_N}{nW} \quad \text{(i)}$$

There are also sales to the government, on which firms are assumed to charge marginal costs only. Thus profits equal the difference between prices and marginal costs times sales to the private sector, less fixed costs.

$$\Pi_N(i) = \frac{W}{a_N}\left[\frac{\theta}{\theta-1} - 1\right]\cdot\phi I\cdot\frac{\theta-1}{\theta}\cdot\frac{a_N}{nW} - WF \quad \text{(ii)}$$

By setting profits to zero and simplifying the equilibrium number of firms is obtained.

$$n = \frac{\phi I}{\theta WF} \quad \text{(iii)}$$

Total output for firm i equals private consumption of good i plus an n th share of government purchases:

$$V_N(i) = \phi I . \frac{\theta-1}{\theta} . \frac{a_N}{nW} . \frac{g}{n} \quad \text{(iv)}$$

Multiplying by the number of firms gives output for the sector as a whole, V_N.

Wages are determined through a bargaining process between a trade union and employers. Labour demand in the tradable sector is given by (1.6) and for the non-tradable sector by equalising the production function (1.9) to output supply (1.11). Total labour demand can be approximated by:

$$L^d(W) = \frac{g}{a_N} + L_O - \epsilon W \qquad (1.12)$$

where L_O captures the non-wage factors affecting labour demand, ie productivity, prices of tradables, price of resource inputs and the taste parameter, and ϵ is the reduced form real wage elasticity. By substituting (1.11) into the union's objective function and solving for w the equilibrium real wage may be derived.

$$W = \frac{\sigma}{\sigma+\epsilon^2} W^* + \frac{\epsilon}{\sigma+\epsilon^2} \left[\frac{g}{a_N} - L^* + L_O \right] \qquad (1.13)$$

where W^* and L^* are the target levels of the real consumption wage and employment and σ is the weight given to the real wage in the union's objective function.

This equation shows that the equilibrium real wage is positively related to the target real wage W^*, government demand and the exogenous factors affecting L_O ie a_T, P_T and P_R; it is negatively related to L^*, the target level of employment. The relative weights give to L^*, and W^*, may be seen as reflecting the relative strengths of 'insiders' and 'outsiders' in the labour force: the more weight given to W^* the greater is the weight given to insiders. The effect of a change in a_N is ambiguous in this model. An increase in non-tradables productivity raises private sector demand for labour, see the second term on the right hand side of equation (1.12). However it reduces government demand for labour, as the first term of the equation shows.

Comparative Statics

The complete model can be used to examine the effects of changes in exogenous variables, ie productivity, world prices of tradable goods and resources, government expenditure and the target real wage. The key relationships are the relative price of tradables to non-tradables, the output of tradables, the nominal wage and the share of tradables in real output since this reflects the allocation of resources between sectors. The response of the current account to the exogenous variables is also of interest.

Table 1.1 sets out the comparative statics.

Table 1.1:

Comparative Statics

		a_T	a_N	g	W^*	P_T	P_R
Competitiveness	$\frac{P_N}{P_T}$	+	-	+	+	-	-
Current account	CA	+	?	-	-	+	-
Output of tradables	V_T	+	?	-	-	+	-
Endogenous productivity	$\frac{V_T}{L_T}$	+	?	+	+	-	-
Share of tradables	S_T	+	?	-	-	+	?

where a_T and a_N are shocks to productivity in the tradable and non-tradable sectors respectively
g is government expenditure on goods and services
W^* is target real wage
P_T is price of tradable goods in domestic currency terms
P_R is price of resources in domestic currency terms.

Among the interesting results to emerge from the model are:

- A rise in productivity in the tradables sector leads unequivocally to an expansion of tradables output which leads to a rise in the relative price of non-tradables and an appreciation in the real exchange rate.[2] It also leads to an increase in tradables output, and this will improve the current account, other things equal. (A rise in a_T also affects wages and the level of consumption. If there is a differential impact over time then there is a possibility that the current account will deteriorate if consumption increases more than output.)

- The reason for the ambiguous effects of a change in productivity in the non-tradables sector, a_N, is essentially because the effects on labour demand and wages are ambiguous. Nevertheless, output of non-tradables will be positively related to productivity, provided that the wage response does not offset the direct production function effect. For this reason a rise in non-tradables productivity is shown as leading to a real depreciation in Table 1.1.

- The qualitative effects of changes in government expenditure, g, and the unobservable target real wage, W^*, are identical. Increases in both lead to an appreciation of the real exchange rate, a deterioration in the current account, and falls in the output and share of tradables. Output per head in the tradables sector rises as a result of decreasing returns in that sector.

- A rise in the world price of tradables, P_T, improves competitiveness and the current account, and raises the share and level of tradable output.

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(2) A rise in P_N/P_T is a real appreciation, ie a loss of competitiveness. Note that there is a formal relationship between price competitiveness and the relative price of tradables and non-tradables in a two-country context as follows:

$$\log q_1 = \gamma\,(\log q_2 - \log q_2^*) + \log \frac{P_T}{P_T^*}$$

where $q_1 = P/P^*$; $q_2 = P_N/P_T$; P, P_N, P_T are aggregate, non-tradable and tradable prices respectively; * denotes the foreign country and γ the weight of non-tradables in the aggregate price level. Thus q_1 and q_2 will be positively related, provided that relative prices do not move by more and in the same direction in the foreign country. A common shock to relative prices might cause this.

- An increase in the price of resource inputs, P_R, in this model raises the relative price of traded goods and reduces competitiveness. Also, by reducing the real consumption wage and the demand for labour in the traded goods sector the equilibrium level of employment falls. On the path to the new equilibrium nominal wages and prices will be rising and output falling.

An implication of this model for the empirical analysis of tradable and non-tradable prices which follows that differences in sectoral productivity are only one of a number of factors which determine relative prices. Government expenditure, the target real wage and exogenous world prices of tradables and resource inputs - both expressed in domestic currency terms - also have an impact. In the model as specified here changes in consumers tastes between tradables and non-tradables affect the real exchange rate or current account via their effect on wages. Thus an increase in demand for non-tradables will tend to raise aggregate labour demand if the demand for tradables remains unchanged. Qualitatively, the effects are similar to a rise in government expenditure.

2. UK Experience

This section looks in detail at UK inflation from the perspective of tradable and non-tradable prices, starting with a description of alternative RPI-based measures and component sub-indices. This is followed by an examination of some statistical properties of the constructed series.

RPI based measures of tradable and non-tradable prices

The choice of the most appropriate measure of tradable and non-tradable prices is not clear-cut. Producer output price indices suffer from having limited coverage of the service sector, and a coverage which varies significantly between countries. Value added deflators, whilst having desirable theoretical properties, are only available annually at a disaggregated level, and are therefore not suitable for monitoring recent trends. This study therefore primarily uses RPI based measures of tradable and non-tradable prices, which are readily available from OECD sources for other countries and can be constructed for the UK.(3) These suffer from the drawback that for tradables the distributor's margin represents a significant proportion of final prices and one which may not respond systematically to foreign competitors' prices.

Access to detailed RPI sub-indices enables some possible alternative definitions within the framework of the RPI to be examined. The main choices are whether to treat prices of items where import penetration is low, but where there is potential international competition, as tradable or non-tradable. Three alternative definitions were considered. These are set out in Table 2.1. The goods and services definition is the most comprehensive and excludes only local authority rates and the community charge, mortgage interest payments, personal articles and dwellings insurance from the total RPI.(4) Both definitions of tradables and non-tradables additionally exclude the rent and water charges sub-components of the housing index, and seasonal foods, in the latter case on the grounds that variation would introduce seasonality into data which is otherwise taken to be non-seasonal.(5) It was also decided to construct RPI series for alcoholic drink and tobacco which exclude excise duties and the ad valorem tax on cigarettes. Annex 1 gives details of the method used to construct these data.

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(3) Comparisons of the RPI with other price indices, eg producer prices, are liable to be misleading because of the different methods of construction. The RPI, and CPIs in other countries, are constructed using chain-linked Laspeyres methods, with annual chaining. Producer prices indices are also current weighted Laspeyres but with weights being revised every five years.

(4) Personal articles and dwelling insurance were introduced into the RPI only in January 1987 and April 1990 respectively.

(5) The RPI for clothing and footwear also displays a strong seasonal pattern, reflecting the January and summer 'sales'.

Table 2.1:

Alternative Definitions of Tradable and Non-Tradable Prices in the RPI[a]

Goods and Services				Total Weight In Index
Goods				
	Seasonal food 22	Non-Seasonal food 130	Alcoholic drink 80	
	Tobacco 36	Household Goods 7	Clothing footwear 59	
	Chemists' goods 17	Purchase of motor vehicles 67	Petrol 33	
	Leisure goods 47	DIY materials 16		584 (65.9)
Services				
	Catering 47	Housing repairs 9	Leisure services 48	
	Household services 48	Personal services 12	Motor vehicle maintenance 21	
	Vehicle tax and insurance 22	Fares and other travel costs 20	Fuel and light 47	
	Rent 35	Water charges 9		302 (34.1)
Set A				
Tradable	As goods but excludes seasonal foods and excise tax on alcoholic drink and tobacco			531 (67.3)
Non-Tradable	As services but excludes rent and water charges			258 (32.7)
Set B				
Tradable	As goods but excludes all food, drink and tobacco			316 (40.0)
Non-Tradable	As services but includes alcoholic drink and tobacco ex tax and non-seasonal foods; excludes rent and water charges			473 (60.0)

(a) Figures are the weights per 1,000 in January 1992; figures in brackets are percentages of totals which are prices of goods and services or tradables and non-tradables.

Classification by whether a sub-index is a good or service has the merit of being relatively unambiguous. It is the definition used by the OECD and is used in the Bank's *Inflation Report*. However, physical characteristics are not necessarily a good guide as to whether a good or service is sheltered from foreign competition. While it appears that few retail services face direct foreign competition this may also be true of some goods retailed in the UK, for example, non-seasonal food, alcoholic drink and tobacco. In all three cases import penetration was low in 1988, the last year for which this information was available.(6) Nevertheless, overseas suppliers may be potential competitors so these items may conform with the concept of tradability used here. The alternative classifications of tradable and non-tradable prices shown in Table 2.1 recognise this ambiguity. Set A, closely following the goods and services definition, treats these three categories as tradable while Set B sees them as non-tradable.

Statistical criteria for deciding the classification of a particular item might be considered, for example the degree to which a sub-index is correlated with other components of tradable or non-tradable prices, or the degree to which it is influenced by exchange rate movements. Some preliminary correlation studies were carried out, but results were sensitive to the exact specification used and inconclusive. An alternative test is to ascertain the influence of competing import prices on non-tradable prices since the weaker it is the more closely does the definition of non-tradables approximate to the theoretical concept. This was applied by seeing which of two possible definitions of non-tradable prices were less influenced by import prices of manufactured goods less ships and aircraft. On this basis set A is to be preferred, since the

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(6) Imports as percentage of home demand:

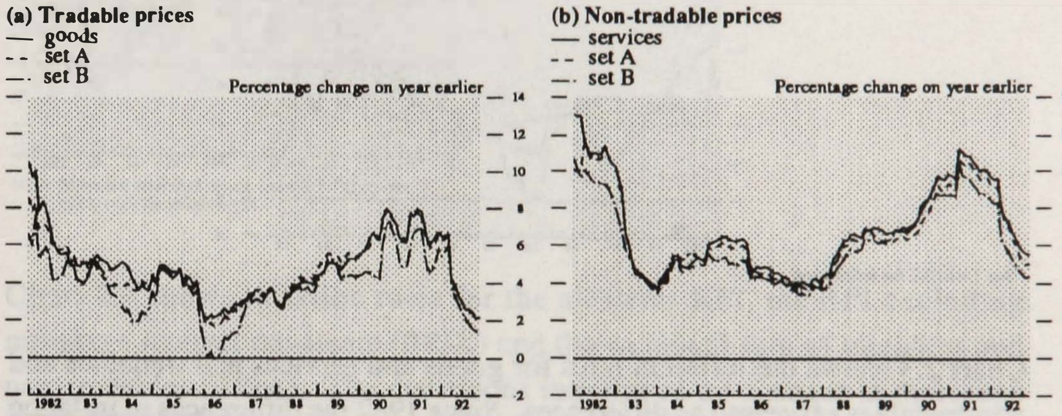
	Food	Drink	Tobacco	(Food, drink tobacco)	Total Manufacturing
1988	16	26	7	(16)	35

Source: Business Monitor MQ12, CSO (1989).

price of competing imports have no influence, see Annex 3. However the test is not conclusive, since no good measures of prices of competing imports of services are available.

The alternative classifications of sheltered and non-sheltered prices shown in Table 2.1 were calculated back to 1974, using the same chain-weighting procedure as in the construction of the RPI itself. Chart 2.1 presents the series as inflation rates for the period 1982 Q1 to 1992 Q4. There are times, especially around 1986 and 1987 after the fall in oil prices and around 1990, when the inflation rates for tradables differ significantly according to the definitions used. The services definition shows, by a small margin, the least slowdown in non-tradable prices in 1991 and 1992.

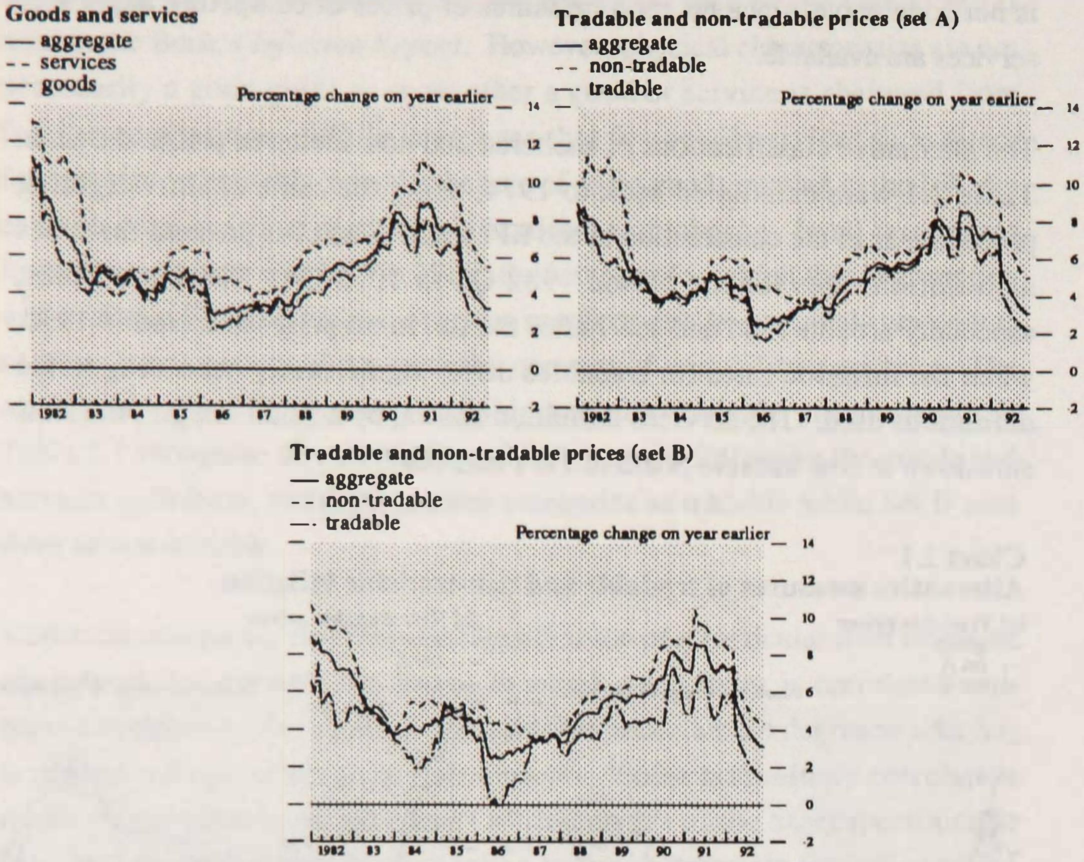
Chart 2.1
Alternative measures of tradable and non-tradable inflation



See Table 2.1 for definitions.

The tradable and non-tradable price series are shown alongside their sum in Chart 2.2

Chart 2.2
Tradable and non-tradable price inflation



See Table 2.1 for definitions.

Chart 2.3 shows the inflation rates for goods and services and tradables and non-tradables expressed as differences. Since 1982 the differences in inflation rates have followed regular cyclical patterns, peaking in 1980-81, 1982, 1984, 1986, 1988 and 1991-92. The gap in 1991 and 1992 was less than in 1981-1982 and 1976 (not shown). However, with the goods and services definition the gap in 1991 and 1992 was higher than in any intervening year, although this was less the case with sets A and B. The gap between the two sectors in 1991 and 1992 was on average slightly larger for goods and services than for set A or set B.(7)

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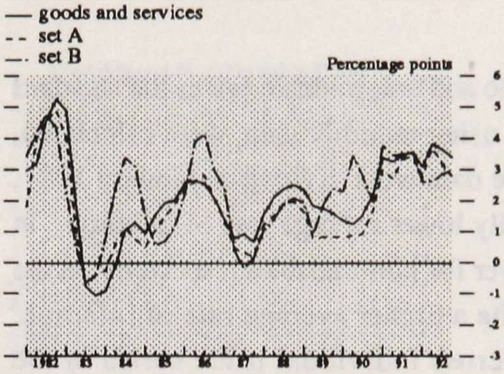
(7) Details of the inflation paths for sub-components of tradable and non-tradable prices for the period 1989-92 were given in the *Bank of England Quarterly Bulletin* (1993).

On the basis of this evidence recent experience is not out of line with that of the last decade. It is interesting to note that the peaks in these series of differences generally occurred when the exchange rate was comparatively strong, as in 1982, 1985 and from 1990 onwards. However, the exchange rate itself was found in econometric work not to have a role in determining the price gap, although variables with which it has a close relationship - competitiveness and competing import prices - were found to be significant.

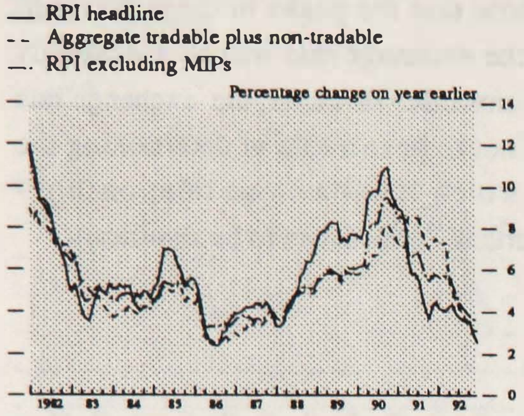
Chart 2.3
Differences in inflation rates in tradable and non-tradable sectors



Note: difference measured as non-tradable inflation rate minus tradable inflation rate.

Chart 2.4 shows inflation rates for the all items RPI, the RPI excluding mortgage interest payments (RPIX) and the weighted sum of tradables and non-tradables (RPIA). The distortions introduced by changes in mortgage interest rates are familiar and account for the bulk of the difference between the all items RPI and the other two series. Seasonal foods, local authority rates and taxes on alcohol and tobacco account for the bulk of the comparatively small difference between RPIX and RPIA inflation rates.

Chart 2.4
RPI Inflation



To assess the relative volatility of tradable and non-tradable prices the standard deviations of the annual inflation rates, using monthly data, were calculated, with the results show in Table 2.2. The data were divided at January 1984, with the second period having a markedly lower average rate of inflation. In both periods, dispersion was slightly lower for non-tradables, especially on the coefficient of variation measure, despite a higher average rate of inflation. This suggests greater homogeneity across individual price series in the non-tradable sector. The mean differences between non-tradable and tradable inflation rates for the period 1984 to 1992 was 1.6 percentage points for set A and 2.2 percentage points for set B.

Table 2.2:
Tradable and Non-Tradable Inflation Rates: Mean and Dispersion

		Tradables	Non-Tradables	Aggregate
January 1975-December 1983				
Set A:	Mean	12.54	15.63	13.35
	SD	4.71	4.50	5.29
	CV	0.38	0.28	0.40
Set B:	Mean	11.60	14.58	
	SD	5.11	4.32	
	CV	0.44	0.30	
January 1984-December 1992				
Set A:	Mean	4.47	6.11	4.98
	SD	2.71	2.24	2.80
	CV	0.61	0.37	0.56
Set B:	Mean	3.68	5.88	
	SD	2.73	2.26	
	CV	0.74	0.38	

SD = Standard deviation of monthly percentage change on year earlier.
CV = Coefficient of variation: standard deviation/mean.

Statistical Properties

The results of statistical tests to determine the time series properties of tradable and non-tradable prices and related macroeconomic variables are presented in Table 2.4. Annex 2 presents the results of Granger causality tests designed to explore interactions between the variables of interest. These are preliminaries to subsequent econometric estimation. Chart 2.5 illustrates the main variables of interest. Table 2.3 gives a full listing of the variables considered.

Chart 2.5 : Price Equations - Main Variables

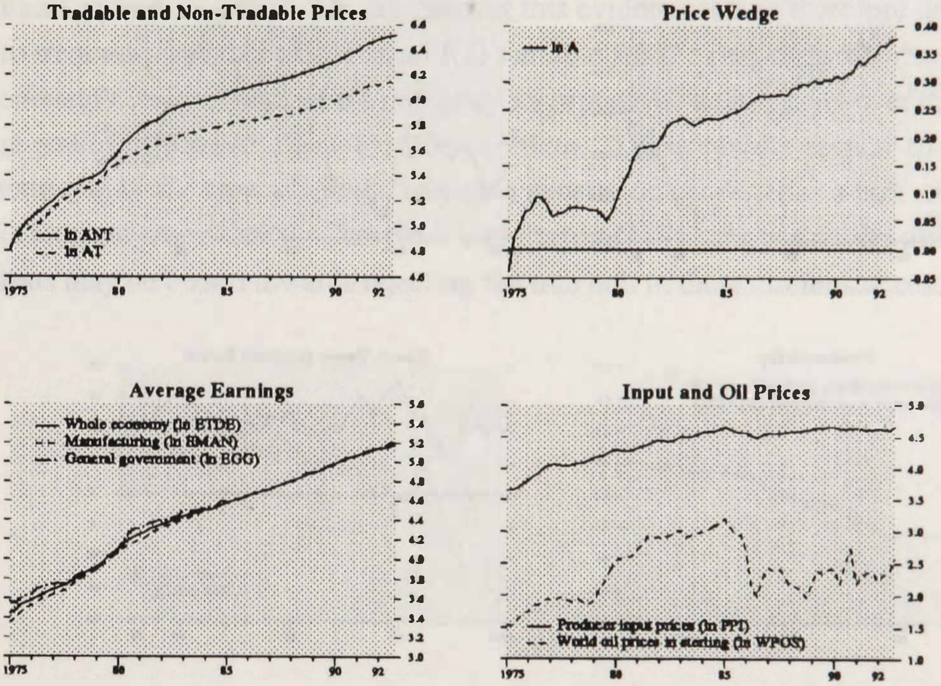
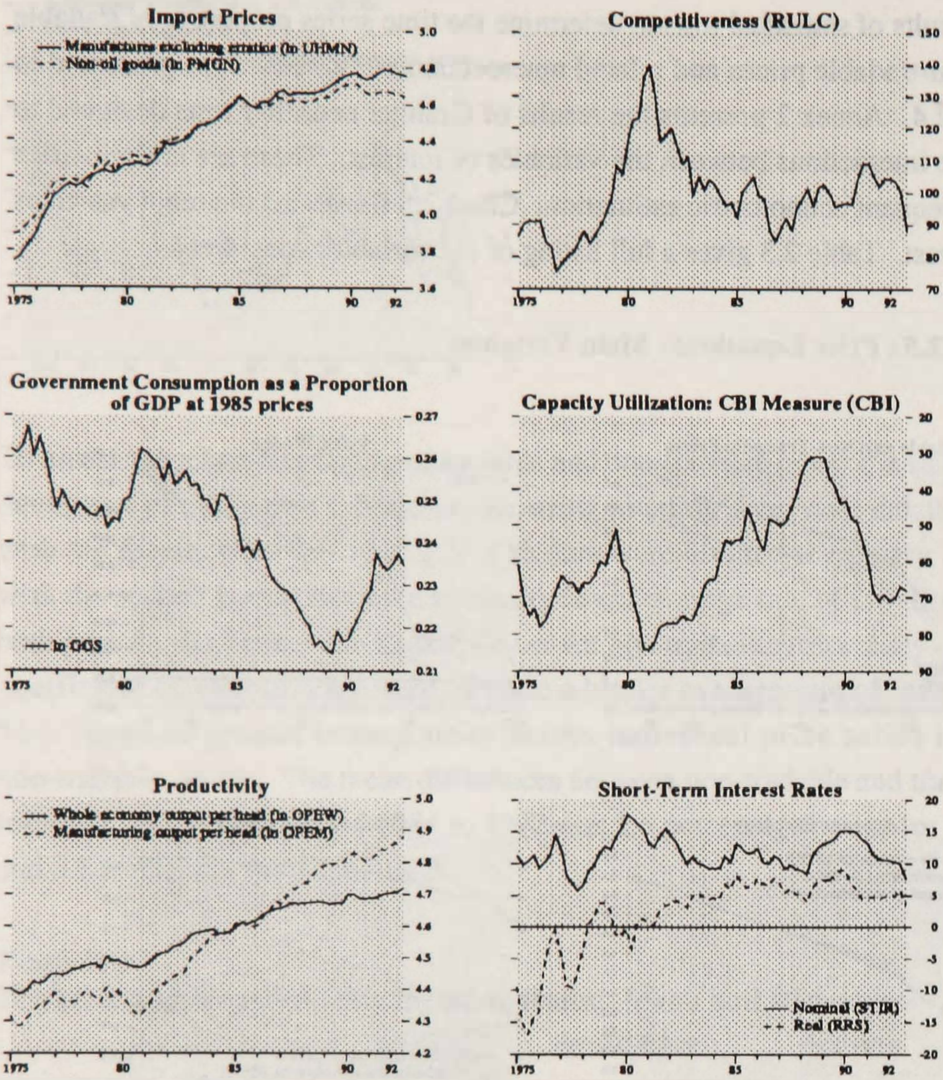


Chart 2.5 : (continued)



Unit root tests were conducted on all the variables of interest for the sample period for estimation, 1975 Q1 to 1992 Q2. The results are given in Table 2.4. As expected most of the variables, including earnings, costs and productivity, were found to be integrated of order one. Surprisingly, both measures of capacity utilisation were also clearly I(1) over the sample investigated. Interest rates were found to be on the borderline of I(1) and I(0). For many of the price series the results of the augmented Dickey-Fuller (ADF) statistics were difficult to interpret. In particular, as Table 2.4 shows, the ADF statistic for the first difference of non-tradable prices (lnANT, lnBNT) were significant, so the null of non-stationarity could not be rejected over this sample. Estimates of an equation to test for unit root in the second difference of non-tradable prices and application of the Johansen procedure were not conclusive. An examination of the spectrum for the difference and second difference of these series suggested that second differencing would overdifference the data. An examination of the data themselves, the first box in Chart 2.5, shows that there is a break in the behaviour of the retail price series in the early 1980s, reflecting a change in the trend growth of prices. On the basis of this evidence it was therefore decided to treat non-tradable prices as an I(1) variable for the purposes of subsequent cointegration analysis, where necessary incorporating a time trend over the first segment of data to allow for this problem. These results appear to be an example of the case where the true data generation process has a unit root but is close to stationarity. Campbell and Perron (1991) show that the unit root tests may be biased towards rejecting the true null in these circumstances.

Table 2.3:

Variable Definitions

Variable	Description	Source
Retail Prices		
ANT	Non-tradable RPI, set A index 1974=100	text Table 2.1
AT	Tradable RPI, set A index 1974=100	text Table 2.1
BNT	Non-tradable RPI, set B index 1974=100	text Table 2.1
BT	Tradable RPI, set B index 1974=100	text Table 2.1
RPIA	RPI index of tradable plus non-tradable 1974=100	text Table 2.1
RPIX	RPI excluding mortgage interest payments	CSO
A	log ANT - log AT	
B	log BNT - log BT	
Other Variables		
CBI	CBI Capacity utilisation: balance of firms reporting working below capacity	CSO: AGG4Y[(1)]
D79Q3	VAT change dummy 1979 Q3=1, 0 otherwise	-
D91Q2	VAT change dummy 1991 Q2=1, 0 otherwise	-
EER	Effective UK exchange rate index 1985=100	CSO: AJHV
EDMS	Sterling/Deutschemark exchange rate	CSO: AJFM
EDG	LogEOTH - logEMAN	
EGG	Average earnings in the public sector	DE Gazette, Table 5.1
EMAN	Index of average earnings (manufacturing) 1985=100	DE Gazette
EOTH	Index of average earnings (other sector) 1985=100	BofE; CSO
ETDE	Actual average quarterly earnings DofE measure 1985=100	DE Gazette, Table 5.1
GGS	General government final consumption, £m 1985 prices as a proportion of GDP at factor cost	CSO: DIAT/CAOP
NNO	Non North sea GDP (output measure)	BofE; CSO
NNOR2	Residual measure of capacity utilisation	see footnote(2)
OHRE	Output per person employed (outside manufacturing) 1985=100	BofE; CSO
OPD	LogOHRE - logOPEM	
OPEM	Output per person employed in manufacturing 1985=100	CSO: DMBF
OPEW	Output per person (whole economy) 1985=100	CSO: DMBE
PMGN	AVI for total non-oil visible imports 1985=100	BofE; CSO
PPI	Producer (input) prices: manufactured industry 1985=100	CSO: DZBR
PPO	Producer (output) prices: all manufactured products 1985=100	CSO: DZCV
PSBRRAT	Ratio of PSBR to money GDP	BofE; CSO
RULC	Relative unit labour costs	BofE
RRS	Real 3-month interbank rate	CSO: AMIJ
STIR	3-month interbank rate	BofE; CSO
UHMN	Import unit value index manufactures excluding erratic items	CSO:BOLV
ULCM	Unit labour costs (manufacturing)	BofE; CSO
WPOD	World price of oil in dollars	BofE
WPOS	World price of oil in sterling	BofE

(1) CSO central database mnemonics.

(2) NNOR2 is the residual from the equation:

$$\ln NNO = \underset{(1092)}{11.1} + \underset{(1.1)}{0.00054T1} + \underset{(8.4)}{0.0059T2}$$

where NNO is non North Sea GDP. Figures in brackets are t statistics. Sample period: 1974 Q1-1992 Q4. T1 starts in 1974 Q1, T2 in 1981 Q1.

Note: BofE = Bank of England forecasting group database.

Table 2.4:

Unit Root Tests

	Level		First Difference		Order of Integration
	ADF(1)		ADF(1)		
	(1)	(2)	(1)	(2)	
Retail Prices					
lnANT	-3.6	-3.3	-2.6*	-3.3*	I(2)/I(1)
lnAT	-4.3	-3.5	-3.1	-4.1	I(1)
lnA	-1.3	-2.6	-5.1	-5.1	I(1)
lnBNT	-3.6	-3.4	-2.6*	-3.4	I(2)/I(1)
lnBT	-4.7	-3.4	-3.3	-4.3	I(1)
lnB	-1.2	-2.8	-5.2	-5.2	I(1)
lnRPIA	-4.0	-3.5	-2.8*	-3.5	I(2)/I(1)
lnRPIXH	-4.4	-3.7	-3.3*	-4.4	I(1)
Other Variables					
lnUHMN	-3.2	-2.5	-4.3	-5.2	I(1)
lnPMGN	-2.7	-1.4	-5.2	-5.8	I(1)
lnWPOS	-2.2	-1.8	-7.1	-7.3	I(1)
lnULCM	-3.3	-2.0	-4.3	-4.4	I(1)
lnPPI	-3.3	-1.8	-5.1	-6.5	I(1)
lnEMAN	-4.3	-1.5	-3.9	-5.0	I(I)
lnEOTH	-3.9	-3.1	-3.3	-3.7	I(1)
lnETDE	-3.4	-2.3	-3.5	-3.7	I(1)
lnOPEM	0.4	-2.0	-5.2	-5.2	I(1)
lnOHRE	-0.7	1.4	-5.4	-5.4	I(1)
lnOPEW	-0.8	-2.1	-5.9	-6.3	I(1)
lnOPD	0.7	-1.7	-5.9	-6.0	I(1)
lnRULC	-1.9	-1.8	-5.1	-5.1	I(1)
lnEER	-2.1	-2.6	-5.7	-5.7	I(1)
lnEDMS	-2.0	-2.7	-5.4	-5.5	I(1)
lnGGS	-1.1	-1.5	-5.1	-5.1	I(1)
CBI	-1.7	-2.0	-4.3	-4.3	I(1)
NNOR2	-1.1	-0.9	-4.4	-4.5	I(1)
PSBRRAT	-3.3	-4.6	-9.7	-9.8	I(0)
STIR	-3.0	-3.0	-5.6	-5.6	I(0)
RRS	-2.3	-3.5	-5.0	-5.0	I(1)

ADF(1) denotes augmented Dickey-Fuller at lag 1

(1) Without trend; 95% critical value = -2.9.

(2) With trend; 95% critical value = -3.5.

* Denotes significant ADF in first difference equation

Sample period 1975 Q1-1992 Q2

3. Estimation Results

The basic approach to modelling prices adopted here follows the cost mark-up hypothesis outlined in the theory section of this paper.(8) This identified wages, productivity and, for tradables, competing world prices as the key determinants. In addition, pressure of demand effects and, for tradables especially, the cost of bought-in inputs need to be considered.(9) Government current demand, according to both theory and the causality tests, may influence non-tradable prices.

These theoretical considerations suggest that long-run or equilibrium prices of non-tradables might be modelled by an equation of the following general form:

$$lnPNT = a_o + a_1 lnOPNT + a_2 lnW + a_3 lnPPI + a_4 lnGGS \quad \textbf{(3.1)}$$

where PNT = non-tradable prices, $OPNT$ = output per head in the non-tradables sector, W = earnings per worker, PPI = index of input prices and GGS = government demand. For prices to be homogenous with respect to costs the coefficient restriction $a_2+a_3-a_1=0$ would need to be satisfied. The coefficient a_3 is expected to be close to zero.

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(8) The general approach is also similar to that featured in most large UK macroeconomic models, see for example Rowlatt (1988) for a detailed exposition of the wage, price, exchange rate block of the Treasury model. However, in such models the main behavioural equation is usually for producer prices.

(9) In theoretical terms pressure of demand effects on the mark-up are ambiguous. For example, Layard and Nickell (1986), Weitzman (1982) and others have put forward reasons why margins may fall in booms; in the former case because marginal costs may rise with output and in the latter from an assumption of procyclical elasticity of demand. See also Jackman, Layard and Nickell (1991) page 339, for a discussion of this issue. Retail prices are not value-added prices so the cost of inputs needs to be included.

Although the theoretical model outlined in Section 1 assumes that firms in the tradable sector equate their prices with given world prices, strict versions of the law of one price are not supported by the causality tests presented in Annex 2 or other empirical work. The specification for tradables therefore allows domestic costs and capacity utilisation as well as competing import prices as determinants of equilibrium tradable prices:

$$lnPT = b_o + b_1 lnOPT + b_2 lnW + b_3 lnPPI + b_4 lnPM \quad (3.2)$$

where *PT* = tradable prices, *OPT* = output per head in the tradable sector and *PM* = price of competing imports.

Subtracting equations (3.2) from (3.1) gives the general specification of the equation for relative prices, the price wedge:

$$lnPW = c_o + c_1 lnOPD + c_2 lnWD + c_3 lnPPl + c_4 lnPM + c_5 lnGGS \quad (3.3)$$

where *OPD* = non-tradable less tradable output per head and *WD* = non-tradable less tradable wages. The expected signs on the coefficients are c_1, c_3 and $c_4 < 0$; c_2 and $c_5 > 0$. If the coefficients $a_2 = b_2$ and $a_3 = b_3$ the respective terms in the price wedge equation would be zero, in which case equation (3.3) reduces to:

$$lnPW = c_o + c_1 lnOPD + c_4 lnPM + c_5 lnGGS \quad (3.4)$$

These relationships form the basis of the cointegrating equations which have been estimated for the three price series. Capacity utilisation and short-term interest rates were also considered in estimation of the cointegrating relationships. This may be justified on empirical grounds: capacity utilisation and real interest rates were found to be I(1) and nominal interest rates on the borderline of I(0) and I(1), with the possibility of cointegrating with price levels.

In estimating the cointegrating equations both OLS and the Johansen maximum likelihood procedure were adopted. The latter has the advantage in that it allows for the possibility that the cointegrating vector may not be unique, while overcoming the problem that OLS estimates may suffer from small sample bias and misleading test statistics, see Hall (1989) for a discussion. In practice, however, the Johansen results were found to be very sensitive to sample and specification. Moreover, the fact that more than one cointegrating vector is obtained makes the results difficult to apply and interpret in the model framework used here. The Johansen results are therefore presented mainly as a check that those obtained by OLS represent a cointegrating set and are not the result of spurious regression, in the sense of Granger and Newbold (1974).

In the absence of priors about the dynamic structure the Engle-Granger two-stage procedure provides a suitable framework for estimation.[10] In this a cointegrating vector which is consistent with theoretical priors may be considered an estimate of the equilibrium price level. The dynamic equation in first difference terms, with the residuals from the cointegrating vector used as an error correction term, then describes the path towards that equilibrium.

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(10) Alternatives may be envisaged. For example, Price (1992) presents a model of UK producer output prices where firms are assumed to minimise a multiperiod quadratic loss function of deviations of actual from equilibrium prices. This provides a testable dynamic structure, in which the fitted values from the first stage equation can be used directly as the measure of equilibrium prices. For the purposes of examining sectoral prices it was decided to retain a backward looking framework, while noting that if a forward looking model is the correct one, an interpretation of the first stage equation as a structural estimate may be invalid.

Thus the general form dynamic equation is:

$$\Delta p = k + \sum_{i=1}^{n} \alpha_i \Delta p_{-i} + \sum_{i=0}^{n} \sum_{j=1}^{k} \beta_{ji} \Delta x_{j,-i} + \gamma RES_{-i} \tag{3.5}$$

where x is the vector of 'other' variables included in the cointegrating vector. In estimating the general models lags up to 2 quarters were considered. The dynamic equations were estimated both by OLS and, where contemporaneous explanatory variables are present, by instrumental variables.

Particular attention has been given to the structural stability of the estimated relationships over the period 1990 Q3 to 1992 Q2, broadly coinciding with UK membership of the ERM, which was from 8 October 1990 to 16 September 1992. Indications of structural instability might suggest that ERM membership had changed expectations formations since it represented a move to a less accommodating policy regime. But such an interpretation needs to be treated cautiously. Backward looking models such as those estimated here are subject to the Lucas critique if the true model is forward looking. Structural instability may therefore indicate that the backward looking model is not the true model independently of any ERM effects. As noted by Price (1992), a backward looking model can be interpreted as a reduced form of a structural system with a forward looking dynamic model and VARs generating the expectational terms, while Hendry (1988) proposes a variance encompassing approach to test between this hypothesis and the rival feedback/conditional model.

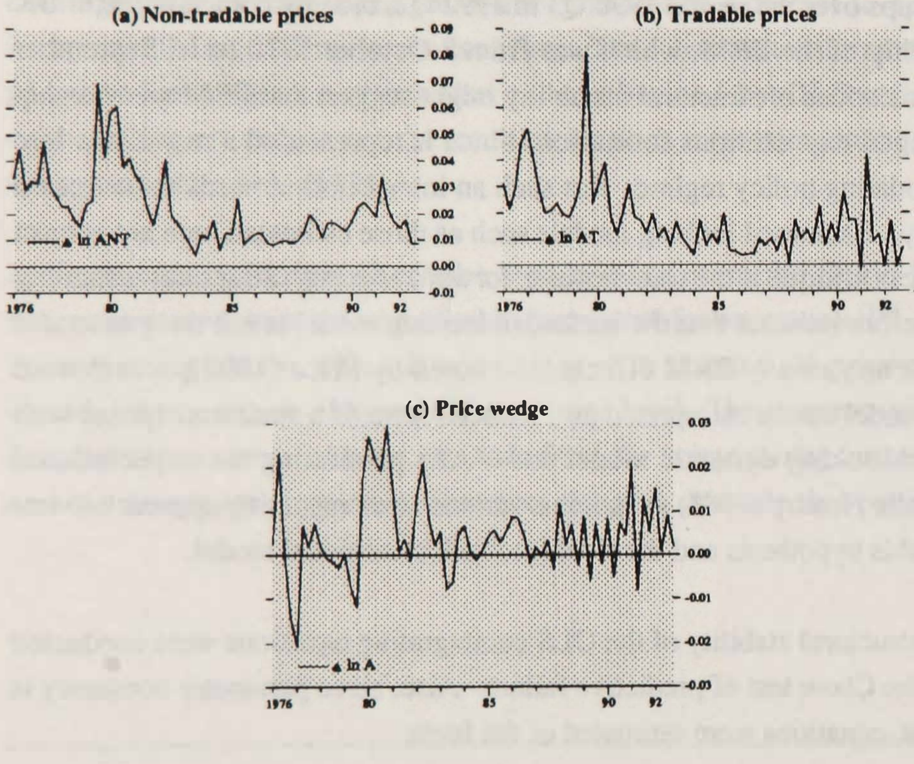
Tests of structural stability of the OLS cointegrating equations were conducted through the Chow test of predictive failure. Also, since parameter constancy is of interest, equations were estimated of the form:

$$p = k + \sum_{j=1}^{k} \beta_j x_j + \sum_{j=1}^{k} \gamma_j w_j x_j \tag{3.6}$$

where w_j is a dummy taking the value 0 up to 1990 Q2 and 1 thereafter. The joint and individual significance of the γ_js is a test of the null hypothesis of parameter constancy of the β_js, see Pagan (1984).

Estimates have been derived both for set A and set B definitions of retail prices. The results below focus on set A; set B results are presented in Annex 3.(11) Estimation results for tradables plus non-tradables are given in Annex 4. Chart 3.1 shows the three price series, expressed as first differences, which are the dependent variables in the dynamic equations.

Chart 3.1 : Dynamic Price Equations - Dependent Variables



(11) The estimation results which follow differ from those reported in *Bank of England Quarterly Bulletin*, February 1993. These were for set B and were estimated before the tests for the effect of import prices on non-tradables and parameter constancy were applied, see Annex 3 para 3.

Non-Tradable Prices

Estimates of the cointegrating equation by OLS suggested that cointegrating vectors could be obtained, broadly consistent with theoretical priors, from prices (ANT), whole economy earnings (ETDE), whole economy or non-manufacturing productivity (OPEW) or (OHRE), input prices (PPI), and real general government consumption as a proportion of GDP (GGS). A split-period time trend (TS), which takes a value of zero after 1982 Q2 and designed to capture the effect of the break in trend identified as the possible reason for the ambiguous unit root test results, was also found to be significant.

The preferred OLS estimate of the cointegrating equation is shown as equation A in Table 3.1. A Wald test of the restriction that the coefficients on ETDE and OPEW were of equal and opposite sign was rejected (χ^2_1=7.9). The sum of the coefficients on earnings and input prices is significantly greater than unity. The coefficient on input prices is large and highly significant, which is consistent with the causality test results but not theoretical priors. The results in Annex 2 show that input prices were significant in, but did not Granger-cause, non-tradable prices. This suggests that non-tradable and input prices may be jointly determined by some other variable such as the aggregate price level. Government expenditure is significant: an estimate from which it is excluded is shown as equation B in Table 3.1. Nominal interest rates cause some difficulties. They are not a feature of the theoretical specification, which is couched in real terms, and are insignificant in the Granger causality tests. Yet they were found highly significant. The coefficient gives a semi-elasticity of -0.007, implying a 1 percentage point rise in interest rates from 10% would lower prices by a little less than 1%. Capacity utilisation, as measured by the residual from trend measure, was insignificant.

When this equation was re-estimated to 1990 Q2 and used to forecast to 1992 Q3 the Chow and F tests of predictive failure were only significant at about the 55% level. However the forecast errors were all negative showing overprediction. Moreover the test for parameter stability shown as LM(5) in Table 3.1, is significant at the 10% level, although all of the individual t statistics were less than unity. The evidence for any structural break in the equilibrium relationship around 1990 is inconclusive, although the negative forecast errors are not inconsistent with the possibility that the recession put downward pressure on equilibrium prices.

Table 3.1:

Cointegrating Equations for Non-Tradable Prices

lnANT	A	B	C
k	1.56	1.34	-
	(17.1)	(23.5)	
lnETDE	0.83	0.89	0.77
	(26.1)	(38.3)	-
lnOPEW	-0.39	-0.87	-0.41
	(-2.1)	(-9.8)	-
lnPPI	0.37	0.39	0.50
	(17.0)	(18.0)	-
lnGGS	0.31	-	I(0)
	(2.9)	-	-
STIR	-0.007	-0.009	I(0)
	(-6.4)	(-8.9)	-
TS	0.0008	0.0003	I(0)
	(2.4)	(1.0)	-
$\bar{R}^2$	0.999	0.999	
SE%	1.49	1.57	
F1,62(1)	-	13.9*	
LM(5)(2)	9.3**	-	-
PRED(3)	8.6	-	-
Estimation Period	75Q2-92Q2	75Q2-92Q2	75Q3-92Q2
Estimation method	OLS	OLS	Johansen

(1) Test of restriction that coefficient on lnGGS=0.
(2) LM test for exclusion of dummy regressors, see equation 3.6.
(3) Chow test (χ^2_8) for adequacy of prediction 1990Q3-1992Q2.
* Significant at 95% level
** Significant at 90% level

Equation C of Table 3.1 is the first vector from a set of four cointegrating vectors. The interest rate was treated as an I(0) variable, consistent with the results of the unit root tests. An estimate of the cointegrating vectors with government expenditure as an I(1) variable (not reported) gave government expenditure with a negative sign. A comparison of equation A with C shows that the coefficients on the main parameters are generally similar, although that on input prices seems implausibly large in the Johansen case. None of the reported cointegrating equations are homogenous with respect to costs.

The dynamic estimates are shown in Table 3.2. Equation (i) and the corresponding (and similar) IV estimate (ii) use the residuals from equation A of Table 3.1 as the error correction term. It is highly significant, and has a start delay of 3 quarters. It suggests that it takes about 2 years for any disturbance away from equilibrium prices to be closed. These equations imply that in the short-run the elasticity of non-tradable price inflation with respect to earnings is close to unity. However, a 1% rise in productivity leads in the short-run to a reduction in inflation of only about 0.2%. Producer input prices have a short-run elasticity of 0.4, rather higher than expected. Equations (i) and (ii) are satisfactory on statistical grounds, although the heteroskedasticity tests are significant at the 20% level, and the RESET test suggests some misspecification. Equation (iii) in Table 3.2 uses the residuals from equation C in the error correction term. The results show some residual heteroskedasticity, but the other reported statistical tests are at least as satisfactory as the OLS based dynamic equation. The presence of a significant LDV and the smaller coefficient on the error correction term are noteworthy features. All the dynamic equations have highly significant terms for the VAT increases in June 1979 and April 1991. In addition a dummy was included to capture the effect of the one-off rises in retail nationalised industry prices introduced after the 1982 budget. The effect of this on the data is clearly seen in Chart 3.1(a).

Table 3.2:

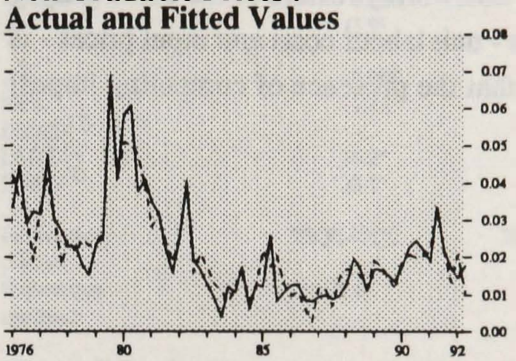
Dynamic Equations: Non-Tradable Prices

ΔlnANT	(i) OLS	(ii) IV[8]	(iii) Johansen	
k	-0.0058 (-2.5)	-0.0079 (-3.0)	k	0.06 (3.5)
$(\sum_{i=0}^{2}\Delta lnETDE_{-i})/3$	1.05 (11.7)	1.14 (11.4)	ΔlnANT(-2)	0.31 (4.7)
ΔlnOPEW	-0.20 (-2.5)	-0.19 (-1.8)	$(\sum_{i=0}^{2}\Delta lnETDE_{-i})/3$	0.75 (6.2)
ΔlnPPI(-1)	0.17 (6.0)	0.16 (5.7)	ΔlnPPI(-1)	0.17 (5.2)
ΔSTIR	-0.0017 (-3.4)	-0.0018 (-3.5)	ΔlnPPI(-2)	0.05 (1.9)
ΔSTIR(-1)	-0.0026 (-4.8)	-0.0027 (-4.9)	ΔSTIR	-0.0012 (-2.5)
D79Q3	0.026 (4.4)	0.025 (4.1)	ΔSTIR(-1)	-0.0013 (-2.3)
D82Q2	0.017 (3.1)	0.017 (3.1)	D79Q3	0.035 (6.2)
D91Q2	0.016 (2.9)	0.017 (3.0)	D82Q2	0.019 (3.6)
RES1(-3)[7]	-0.21 (-4.3)	-0.21 (-4.2)	D91Q2	0.014 (2.6)
			RES2(-3)	-0.089 (-3.9)
$\bar{R}^2$	0.84	0.84		0.86
SE%	0.54	0.55		0.51
LM(4)	6.2	6.5		0.40
RESET[2]	4.9*	0.9		2.0
NORM[3]	0.4	0.4		0.04
HETER[4]	1.6	1.7		4.1*
LM(11)[5]	13.8	-		-
PRED[6]	4.3	-		6.2

(1) LM(4) test of residual serial correlation.
(2) Ramsey reset test for functional form distributed X_1^2.
(3) Test of normality of residuals, X_2^2.
(4) Test of residual heteroskedasticity, X_1^2.
(5) LM test of exclusion restrictions against general form: ETDE treated as separate terms.
(6) Chow test for adequacy of prediction 1990Q3-1992Q2.
(7) RES1 is residual from equation A, Table 3.1; RES2 is residual from equation C, Table 3.1.
(8) Instruments used: ΣΔETDE(-1), ΔlnOPEM.
* Significant at 95% level;
Estimation period 1976Q1-1992Q2

Equation (i) was re-estimated to 1990 Q2 and used to forecast the subsequent nine quarters conditional on the forecast values from the cointegrating equation, which was also re-estimated to 1990 Q2. (The dependent variable was adjusted in this and all subsequent forecast tests for the effects of the VAT change in 1991 Q2 by using the estimated coefficient on the dummy in the full sample equation.) The Chow and F tests were only significant at the 12% level, so there is no evidence of predictive failure and none of bias in the forecast errors. A similar exercise carried out with equation C, but conditional on the full sample Johansen equation, also showed no signs of predictive failure. Actual and predicted values for the full sample equation are shown in Chart 3.2.

Chart 3.2
Non-Tradable Prices :
Actual and Fitted Values



—— Actual values Δ ln ANT
- - - Fitted values from equation (i), Table 3.2.

Tradable Prices

The starting point for estimation of the cointegrating vectors for tradable prices is equation (3.2). Alternative measures of the effect of import and competitiveness prices were investigated at an early stage. Of these the price index of finished manufactures less ships and aircraft (UHMN) was preferred on both theoretical and empirical grounds. The causality tests in Annex 2 show that real but not nominal interest rates cause tradable prices. An estimate of equation (3.2) with UHMN and augmented by real interest rates and capacity utilisation (CBI measure) is shown as equation A of Table 3.3. Both CBI and input prices were insignificant.(12)

Application of the dummy variable procedure to test for the parameter stability of equation A showed strong evidence of structural break around 1990 Q2; the test statistic is significant at the 99% level. Examination of the t statistics on individual dummy weighted variables showed that producer input prices and CBI capacity utilisation were largely responsible for the instability.(13) When re-estimated to 1990 Q2, the equation also gave a strong evidence of predictive failure. The preferred OLS cointegrating vector shown as equation B. The exclusion of CBI and PPI was easily accepted by the data. There are no indications of either parameter unstability or predictive failure over the 8 quarters to 1992 Q2 in equation B. A noteworthy feature of the cointegrating equations is that the coefficient on costs - unit labour costs and input prices - is significantly below unity. It is likely that the presence of competing import prices is the main reason for this result.

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(12) The CBI measure of capacity utilisation was used since it relates more closely to manufacturing, and hence tradables, than does the constructed variable NNOR2. Higher values of CBI represent lower levels of capacity utilisation, so the negative sign implies a procyclical mark-up over costs.

(13) The individual parameter estimates showed that over the period 1990 Q3 to 1992 Q2 the equilibrium CBI effect weakened (became less negative) and that on import prices strengthened compared with the period up to 1990 Q2.

Table 3.3:

Co-Integrating Equations for Tradable Prices

lnAT	A	B	C
k	0.20	0.22	-
	(2.3)	(3.8)	
lnULCM	0.66	0.67	0.45
	(25.1)	(38.9)	-
lnUHMN	0.52	0.55	0.78
	(16.2)	(24.9)	-
lnPPI	0.053	-	-0.11
	(1.5)		-
RRS	-0.0050	-0.0044	I(0)
	(-7.0)	(-7.2)	
lnWPOS	-	-	0.02
CBI	-0.0002	-	-
	(-0.9)		
D79Q3	0.028	0.032	-
	(1.9)	((2.2)	
$\bar{R}^2$	0.998	0.998	
SE%	1.42	1.44	
F(2,62)[1]	-	1.6	
LM(8)[2]	16.2*	1.5	
PRED[3]	25.1*		
Estimation period	75Q2-92Q2	75Q2-92Q2	75Q3-91Q4
Estimation method	OLS	OLS	Johansen

(1) F test of exclusion restrictions against equation A.
(2) LM test for exclusions of structural break dummies.
(3) Chow test for adequacy of prediction 1990Q3-1992Q2.
* Significant at 95% level

Estimates of the dynamic equations for tradable prices were obtained using cointegrating vectors B and C of Table 3.3. The same dynamic specification - with the exception of an additional lagged term in ΔCBI - was found to be applicable also in the Johansen based equation.

Table 3.4:

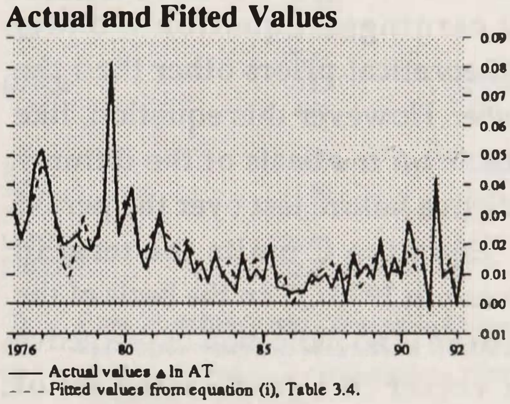
Dynamic Equations for Tradable Prices

ΔlnAT	(i) OLS	(ii) IV[4]	(iii) Johansen
k	0.0041	0.0044	0.052
	(3.4)	(3.5)	(3.2)
ΔlnAT(-2)	0.28	0.26	0.25
	(4.4)	(3.8)	(4.0)
ΔlnULCM(-2)	0.24	0.25	0.21
	(5.5)	(5.5)	(4.9)
$\Delta\Delta$lnPPI	-0.11	-0.10	-0.12
	(-3.7)	(-2.6)	(-4.0)
ΔlnPPI(-2)	0.09	0.10	0.08
	(2.7)	(2.9)	(2.7)
ΔlnUHMN	0.12	0.10	0.14
	(3.5)	(2.3)	(4.4)
ΔlnWPOS	0.02	0.02	0.02
	(4.5)	(4.5)	(5.0)
ΔCBI(-1)	-0.0007	-0.0007	-0.0007
	(-3.5)	(-3.4)	(-3.2)
ΔCBI(-2)	-	-	0.0043
			(2.5)
$\Delta\Delta$RRS[1]	-0.0014	-0.0011	-0.0014
	(-4.9)	(-3.5)	(-5.3)
D79Q3	0.041	0.041	0.039
	(7.0)	(7.0)	(6.9)
D91Q2	0.026	0.025	0.024
	(4.7)	(4.5)	(4.7)
RES1(-3)[2]	-0.10	-0.11	-0.078
	(-2.0)	(-2.1)	(-2.9)
$\bar{R}^2$	0.86	0.86	0.87
SE%	0.52	0.52	0.49
LM(4)	4.8	4.5	2.7
RESET	3.0**	3.8*	3.6*
NORM	0.80	0.74	0.58
HETERO	0.35	0.16	0.31
LM(10)[3]	9.1	-	-
PRED	5.3	-	5.7

(1) $\Delta\Delta RRS = \Delta RRS - \Delta RRS_{-2}$.
(2) Equations (i) and (i) use residuals from equation B, equation (iii) uses residuals from equation C, Table 3.3.
(3) LM test against general form equation, but with no restrictions on ΔRRS and ΔPPI terms.
(4) Lagged values of ΔlnUHMN, ΔlnPPI, and contemporaneous nominal interest rates and dollar oil prices used as instruments.
* Significant at 95% level
** Significant at 90% level
See Table 3.7 for definitions of test statistics
Estimation period 1976Q1-1992Q2

The dynamic equations are mostly satisfactory on statistical grounds. There is some indication of functional form misspecification. The equation fits the data well, and there is no indication of predictive failure, although the forecast errors are on average positive, suggesting a tendency for the equations to underpredict. This is not consistent with the story that the combined effects of the recession and ERM membership have led to a change in pricing behaviour for tradable goods. However, as Chart 2.5 shows the period 1990 Q2 to 1992 Q2 was marked by a slow growth of unit labour costs and competing import prices, and these two factors explain most of the observed slowdown in tradable price inflation.

Chart 3.3
Tradable Prices :
Actual and Fitted Values



Price Wedge

The price wedge is defined as non-tradable prices minus tradable prices, as in equation (3.3). The following long-run coefficients in the cointegration vectors may be expected:

Productivity[1] difference	Earnings[1] difference	Import prices	Capacity utilisation	Government expenditure
0<1	-1<0	-1<0	-1<1	0<1

(1) Productivity and earnings differences are defined as non-manufacturing less manufacturing, proxying non-tradables and tradables respectively.

It proved difficult to obtain estimates which were consistent with these priors. In particular, the coefficient on the earnings difference variable (EDG), was found to be negative and highly significant. Also, whole economy earnings (ETDE) was highly significant, although it does not appear in the theoretical specification. (When ETDE was omitted the coefficient on the earnings difference variable is correctly signed but that on import price became positive.) Equation A of Table 3.5 is an estimate of equation (3.3) including, additionally, oil prices, capacity utilisation and whole economy earnings. Equation B omits insignificant terms, and satisfies theoretical priors other than the coefficient on the earnings difference. However this equation, like equation A, was found to be unstable on the basis of the dummy variables test (χ^2_5 = 14.8) and a predictive failure test over the period 1990 Q3 to 1992 Q2 (χ^2_8 = 15.8). Equation C omits the term in productivity.[14] It is stable over a break in 1990 Q2 on the basis of the dummy variables test (χ^2_4 = 2.2), and there is no indication of predictive failure. Equation D is the first vector of a five vector set of cointegrating vectors estimated using the Johansen technique. The coefficients on both the wage difference and government expenditure are smaller than in the OLS estimates: those on whole economy earnings and import prices are of similar magnitude.

(14) A possible reason why including the productivity difference variable over the full sample induces instability is that unlike in the 1980-82 recession, productivity growth in manufacturing continued to rise relative to non-manufacturing from 1990 to 1992. However with set B data the inclusion of the productivity difference variable does not cause instability, see Annex 3.

Table 3.5:

Cointegrating Equations for Price Wedge

lnA	A	B	C	D
K	-0.085	0.025	-0.044	-
	(-0.4)	(0.2)	(-0.4)	
lnOPD	-0.086	-0.094	-	-
	(-1.6)	(-2.3)		
lnETDE	0.25	0.25	0.29	0.30
	(9.2)	(10.1)	(13.0)	-
lnEDG	-0.73	-0.65	-0.79	-0.27
	(-3.6)	(-4.0)	(-5.0)	-
lnGGS	0.14	0.22	0.13	0.017
	(0.8)	(3.5)	(2.5)	-
lnUHMN	-0.14	-0.14	-0.14	-0.21
	(-1.8)	(-2.8)	(-4.0)	-
lnPPI	0.0032	-	-	-
	(0.04)			
lnWPOS	0.0006	-	-	-
	(0.04)			
CBI	0.0003	-	-	-
	(0.6)			
D79Q3	-0.67	-0.068	-0.077	I(0)
	(-4.0)	(-4.2)	(-4.7)	
$\bar{R}^2$	0.974	0.975	0.974	
SE%	1.60	1.57	1.62	
F(1)	-	0.5	1.4	
LM(2)	26.8*	14.8*	2.2	
PRED(3)	32.4*	15.8*	2.5	

(1) F test for exclusion restrictions against equation A.
(2) LM test for exclusions of structural break dummies.
(3) Chow test for adequacy of predictions 1990Q3-1992Q2.
* Significant at 95% level

The general form dynamic equation (not reported) included current and lagged terms in CBI capacity utilisation and short-term interest rates as well as those appearing in the cointegrating relationship. Both additional variables may be expected to have dynamic but no long-run effects, despite their absence in the preferred cointegrating relationship. The preferred equations are shown in Table 3.6.

Table 3.6:

Price Wedge Dynamic Equations

ΔlnA	(i) OLS	(ii) IV(2)		(iii) Johansen
k	0.0048	0.0047		-0.019
	(5.3)	(4.2)		(-4.2)
ΔlnA(-2)	0.17	0.16		-
	(2.0)	(1.9)		-
ΔlnEDG(-2)	-0.14	-0.14		-0.20
	(-1.9)	(-1.7)		(-2.7)
ΔlnUHMN	-0.054	-0.049		-0.093
	(-1.6)	(-0.7)		(-2.6)
ΔCBI	0.0008	0.0006		0.0006
	(4.2)	(1.2)		(3.4)
ΔCBI(-1)	0.0005	0.0005		0.0005
	(2.6)	(2.5)		(2.1)
ΔCBI(-2)	-0.0003	-0.0003		-0.0005
	(-1.5)	(-1.2)		(-2.8)
ΔSTIR(-1)	-0.0020	-0.0024		-0.0026
	(-4.3)	(-4.1)		(-4.6)
D79Q3	-0.024	-0.025		-0.016
	(3.6)	(-3.4)		(-2.6)
D82Q2	0.012	0.12		-
	(2.0)	(2.0)		
D91Q2	-0.020	-0.019		-0.021
	(-3.3)	(-2.6)		(-3.5)
RES1(-1)(1)	-0.28	-0.29	RES2(-3)	-0.24
	(-5.1)	(-4.8)		(-5.5)
$\bar{R}^2$	0.65	0.65		0.64
SE%	0.56	0.56		0.57
LM(4)	1.38	1.76		0.26
RESET	0.11	0.27		0.20
NORM	0.98	0.52		4.9**
HETERO	0.003	0.018		0.005
LM(13)	11.5	-		-
PRED(8)	5.7	-		-

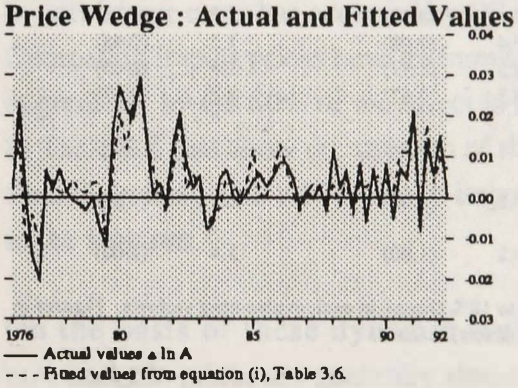
(1) RES1 is residuals from equation C, RES2 is residuals from equation D, Table 3.5.
(2) Lagged values of ΔUHMN and ΔCBI used as instruments.
** Significant at 90% level
See Table 3.2 for definitions of test statistics
Estimation period 1976Q1-1992Q2

The error correction terms proved highly significant, and the coefficients suggest that deviations from equilibrium are mostly closed after about four quarters. Other features of the dynamic estimates of interest are:

- a rise in interest rates reduces the price wedge, implying that it bears down more on non-tradable prices than tradables prices;
- a fall in capacity utilisation (rise in CBI) increases the price wedge, implying that tradable prices fall in relation to non-tradable prices, consistent with the tradable price estimates which show a pro-cyclical capacity utilisation effect;
- the perverse sign on the earnings differences in the cointegrating equation carries over to the dynamic equations.

The reported equations are satisfactory on all the reported tests, with the exception of the normality test with the Johansen estimate. When re-estimated to 1990 Q2 and used to forecast to 1992 Q2 equation (i) on average overpredicts the change in the wedge, but not significantly so.

Chart 3.4
Price Wedge : Actual and Fitted Values



Dynamic Analysis

As Chart 2.2 shows, there has been a tendency for non-tradable price inflation to lag behind the slowdown in RPI inflation, as in 1982, 1986 and 1991 and 1992. One possible reason for this is that non-tradable prices are influenced less or not at all by the main determinants of the general slowdown in inflation. Evidence in support of this has already been presented: the absence of any effects from import prices or capacity utilisation can be cited. Another aspect is the speed of adjustment. Non-tradable prices may respond more slowly than tradable prices to shocks to the main explanatory variables. To investigate this the dynamic responses of prices to shocks to the main determining variables have been calculated.(15) The results are summarised in Table 3.7.

Table 3.7:

Dynamic Response Multipliers(1)

Non-Tradable Prices

		Earnings (lnETDE)		Productivity (lnOPEW)		Input Price (lnPPI)	
Q	0	2.6	(0.41)	-0.4	(0.51)	0	(0.00)
	1	5.1	(0.82)	-0.4	(0.48)	1.3	(0.46)
	2	7.7	(1.22)	-0.4	(0.48)	1.3	(0.46)
	3	8.4	(1.34)	-0.5	(0.57)	1.9	(0.66)
	4	8.7	(1.38)	-0.5	(0.67)	2.2	(0.78)
	8	6.9	(1.10)	-0.8	(0.96)	2.9	(1.02)
	12	6.1	(0.98)	-0.8	(1.00)	2.8	(1.00)
	20	6.3	(1.00)	-0.8	(1.00)	2.8	(1.00)

(1) Percent change from base of prices with respect to 10% change in each explanatory variable. Figures in brackets are proportions of long-run effect (20 quarters) reached.

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(15) The dynamic responses were calculated for non-tradable prices using equation (i), Table 3.2 with equation A, Table 3.1 substituted into the error correction term. For tradables, equation (i), Table 3.4 and equation B, Table 3.3 were used. The dynamic equations were transformed to levels, and simulations of a constant (10%) change in the variables of interest calculated from 1980 Q1 to 1992 Q1. Both equations are dynamically stable.

Table 3.7: (continued)

Tradable Prices

		Unit Labour Costs (lnULCM)		Input Prices (lnPPI)		Competing Import Prices (lnUHMN)	
Q	0	0	(0.00)	-0.9	(-2.2)	0.9	(0.23)
	1	0	(0.00)	0	(0.0)	0.9	(0.23)
	2	1.9	(0.36)	0.4	(1.0)	1.1	(0.29)
	3	2.4	(0.46)	0.8	(2.0)	1.4	(0.36)
	4	3.5	(0.77)	0.9	(2.3)	1.8	(0.46)
	8	5.2	(1.00)	0.9	(2.3)	3.0	(0.78)
	12	5.6	(1.06)	0.6	(1.5)	3.7	(0.95)
	20	5.3	(1.00)	0.4	(1.0)	3.9	(1.00)

(1) Percent change from base of prices with respect to 10% change in each explanatory variable. Figures in brackets are proportions of long-run effect (20 quarters) reached.

For non-tradables there is marked short-run overshooting on earnings, but the response has stabilised by about Q8. As expected, the productivity effect is slower to build up, but by Q8 the full effect has appeared. The small long-run elasticity of productivity is noteworthy. For tradable prices, shown in the lower half of Table 3.8, there is overshooting for input prices, explained by their absence in the estimated cointegrating vector. The full effect of a change in unit labour costs has occurred by Q8, after an initial start delay of 2 quarters. Competing import prices have an immediate effect. But the build-up thereafter is gradual; by Q8 80% of the effect is through and by Q12 95%. The figures in Table 3.8 also show the strength of the effect of competing import prices on tradable prices, with a 10% rise in import prices leading to a rise of almost 4% in the long run.

On the basis of these dynamic multipliers, there is no evidence that non-tradable prices are generally slower to respond to their determinants than tradable prices. Tradable prices also respond rapidly to changes in domestic costs.

Encompassing Tests

Taking the difference of the fitted values of the preferred equations for tradable and non-tradable prices provides an alternative way of explaining the price wedge. (Their sum also gives an estimate of aggregate retail prices (RPIA), see Annex 4 for estimates and associated encompassing tests.) Tests were conducted to see whether the price wedge equation encompassed the disaggregated approach.

In contrast to the usual case where the aggregate equation is compared with the sum of disaggregated equations, see for example Joyce (1990), the test here is to see whether the aggregate (ΔlnA) outperforms the difference between the disaggregated price equations ($\Delta lnANT$ - $\Delta lnAT$), denoted $\Delta lnDIF$. In the first test the following equation was estimated:

$$\Delta lnA = a_o + a_1 \Delta lnA_p + a_2 \Delta lnDIF_p + u \qquad (3.7)$$

where subscript p is the predicted value. An insignificant t ratio on either a_1 or a_2 would imply that the model concerned did not add to the prediction of the other.

In the second test the predicted values of one model are regressed on the equation errors of the other. A significant coefficient on the predicted values would suggest that the model helps to explain the errors of the other. To test this regressions of the following form were estimated:

$$\Delta lnA_r = b_o + b_1 \Delta lnDIF_p + u \qquad (3.8)$$

$$\Delta lnDIF_r = c_o + c_1 \Delta lnA_p + u \qquad (3.9)$$

where subscript r indicates the equation residual.

These tests were conducted using the fitted values and residuals from equations A of Tables 3.2 and 3.4 to give $\Delta lnDIF_p$ and $\Delta lnDIF_r$ and Table 3.6 to give ΔlnA_p and ΔlnA_r. The results are set out in Table 3.8.

Table 3.8:

Encompassing Tests

Dependent Variable	Explanatory Variables k	ΔlnA_p	$\Delta lnDIF_p$	
ΔlnA	-0.0003 (-0.4)	0.66 (6.0)	0.39 (4.0)	(i)
ΔlnA_r	-0.0007 (-1.1)	-	0.17 (2.4)	(ii)
$\Delta lnDIF_r$	-0.0007 (-0.8)	0.15 (1.7)	-	(iii)

Estimation period 1976 Q1-1992 Q2

Equation (i) in Table 3.8 shows that the fitted value of both the disaggregated and the price wedge equations contribute to an explanation of the price wedge. This indicates that both models explain the price wedge, and that neither encompasses the other. Equation (ii), corresponding to (3.8), suggests that there is some information in the disaggregated equations which would help to explain the price wedge. But equation (iii), corresponding to (3.9), also suggests that there is information in the price wedge for the disaggregated equations, although at a lower level of significance than in equation (ii).

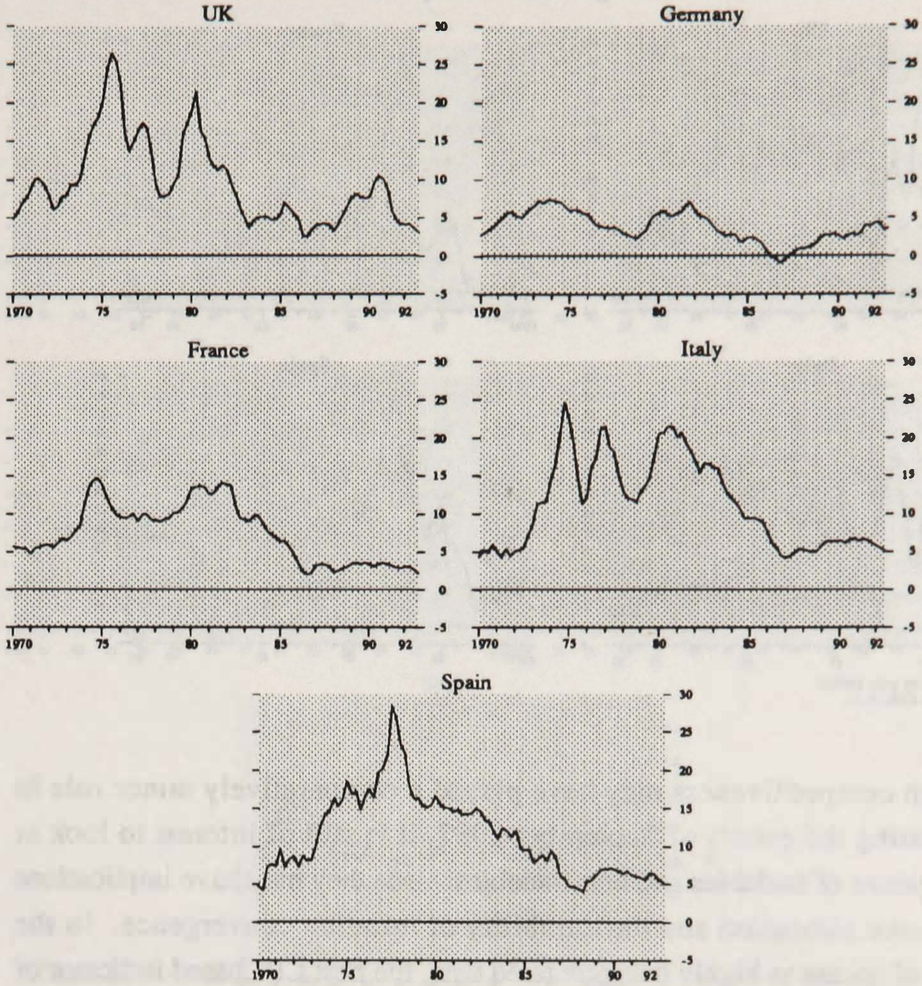
The evidence from these tests is therefore that neither approach to explaining the difference between tradable and non-tradable prices encompasses the other. But, there is some, weaker, evidence that the disaggregated equations have information which is not captured in the price wedge equation.

4. European Experience

In the extensive literature on ERM, EMU and EC convergence questions only a few recent papers have addressed the topic of sectoral price performance. Examples are the papers by Giovannini (1992), De Gregorio *et al* (1993) and Rebelo (1992). To add to this under-researched area and to put the UK trends into context, this section presents CPI data for tradables and non-tradables for other major European economies, using OECD data for France, Germany, Italy and Spain.

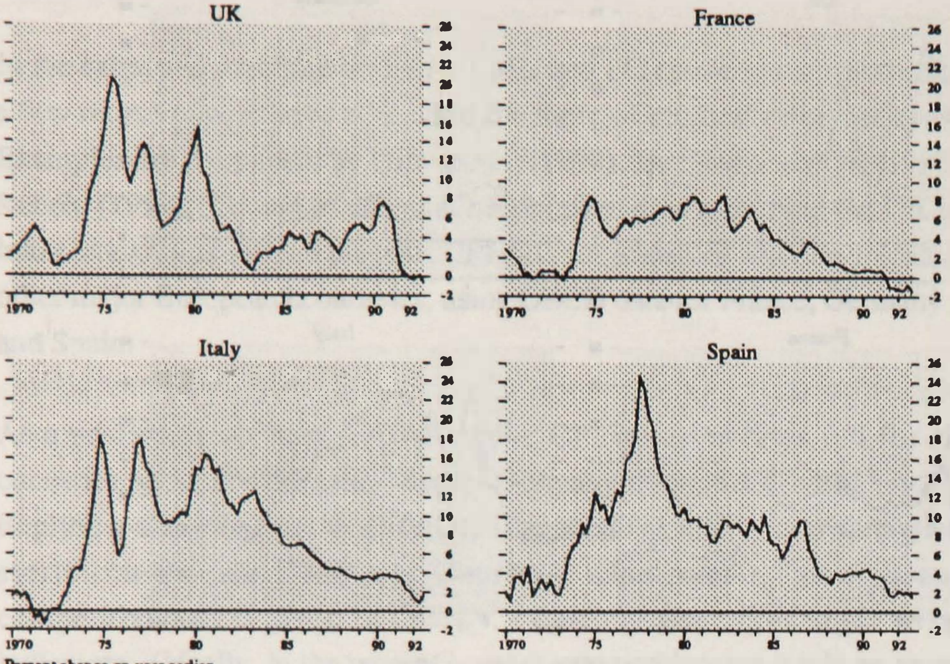
As a preliminary Chart 4.1 shows that CPI inflation rates fell for all the countries under consideration except Germany through 1991 and 1992. This implied a sharp fall in the differential against Germany, continuing a trend started in the mid 1980s, as Chart 4.2 illustrates. The evidence on competitiveness is given in Chart 4.3 which presents IMF trade weighted indicators. (Ideally, in the present context, competitiveness might be measured against other EC countries.) For Italy relative unit labour costs have shown a trend rise since the early 1980s, for Spain both indicators have risen since 1987. In the UK these indicators of competitiveness were, in 1991 and 1992, not out of line with the average of the previous ten years. Thus it seems unlikely that, except in the cases of the Lira and possibly of the Peseta, overall inflation convergence or competitiveness were major factors precipitating the September 1992 and subsequent currency crises. This is also the conclusion reached by Eichengreen and Wyplosz (1993).

Chart 4.1 : Main European Countries CPI Inflation



Percent change on year earlier.
Sources : UK - all items RPI ; Italy - ISTAT ; other countries - OECD.

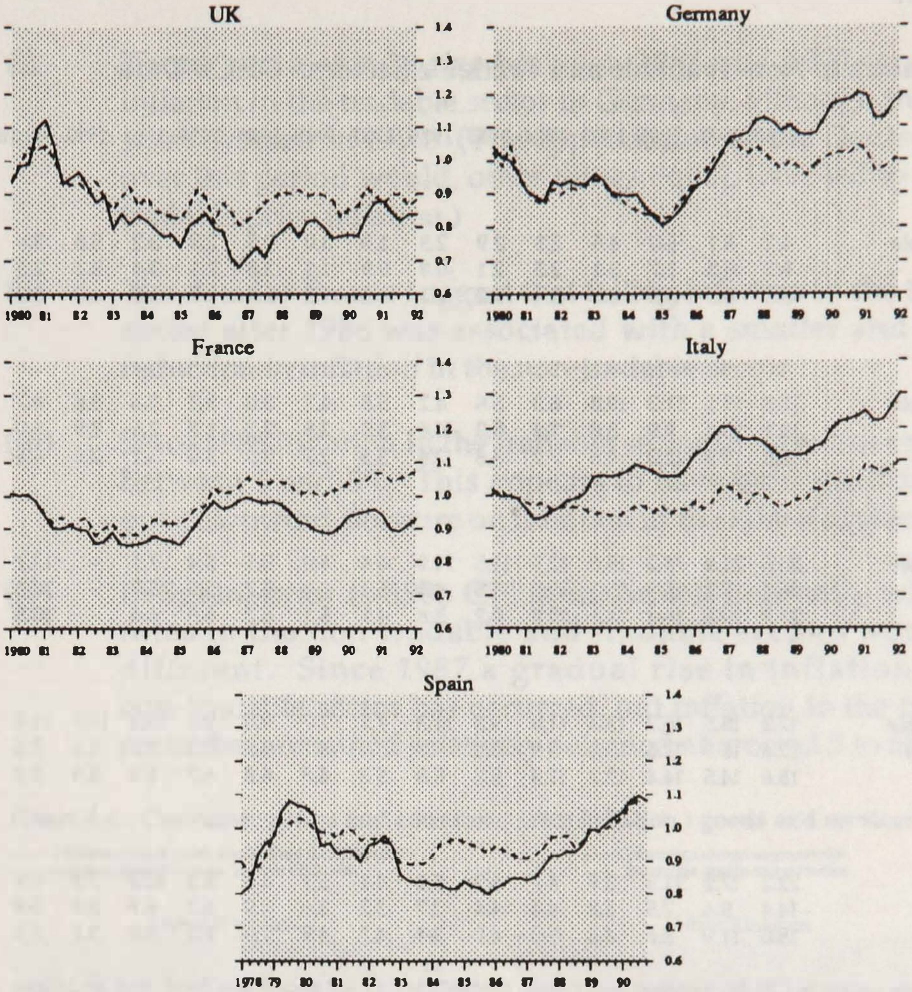
Chart 4.2 : Inflation Differentials against Germany



Percent change on year earlier.
Sources : as for Chart 4.1.

Although competitiveness may have played a comparatively minor role in precipitating the events of September 1992, it is still of interest to look at relative prices of tradables and non-tradables, since they may have implications for resource allocation and the durability of inflation convergence. In the absence of access to highly disaggregated data, the best CPI-based indicator of prices which correspond to the tradable and non-tradables sectors are those derived from OECD disaggregated national CPI data. From these the component 'all goods less food, fuel and electricity' has been constructed and used as an indicator of traded goods prices. Non-traded goods prices are proxied by the component 'services less rents'. The sectoral CPI data, which are derived from national sources, are presented in Table 4.1 and Chart 4.4.

Chart 4.3 : Competitiveness Indicators



——— Relative unit labour costs (1980=1.0).
- - - - - Relative export prices (1980=1.0).

Source: Bank of England database.

Table 4.1:

CPI Inflation in Non-Tradable and Tradable Sectors: OECD Data

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	Mean
<u>Germany</u>														
Non-tradable	4.2	6.1	6.0	4.6	2.3	2.9	2.5	1.9	3.0	2.5	2.3	3.2	5.8	3.6
Tradable	6.3	6.3	3.7	3.1	2.3	2.1	-0.8	0.9	1.1	2.8	2.1	3.4	3.2	2.8
All items	5.6	6.3	5.3	3.3	2.4	2.2	-0.1	0.2	1.3	2.8	2.7	3.5	4.0	3.0
<u>France</u>														
Non-tradable	12.8	13.1	11.3	10.8	6.3	5.6	4.2	5.5	4.2	3.0	3.2	3.6	3.8	6.7
Tradable	13.1	10.4	9.9	8.8	7.4	5.3	6.6	3.9	2.5	2.2	1.7	2.6	2.9	5.9
All items	13.5	13.3	12.0	9.5	7.7	5.8	2.6	3.3	2.7	3.5	3.4	3.1	2.8	6.4
<u>Italy</u>														
Non-tradable	20.6	21.9	18.2	15.6	12.1	11.5	11.9	6.4	6.9	8.1	5.4	7.1	-	12.2
Tradable	26.7	17.2	16.8	13.1	10.1	8.5	4.4	5.1	5.1	5.2	5.9	5.7	-	10.3
All items	21.2	19.6	16.4	14.6	10.8	9.2	5.8	4.7	5.1	6.2	6.5	6.4	-	10.5
<u>Spain</u>														
Non-tradable	17.2	15.5	16.2	13.3	11.0	9.3	11.3	7.7	7.7	9.0	9.1	10.2	10.7	11.4
Tradable(1)	17.6	10.9	12.6	12.0	9.9	8.6	6.9	5.0	3.7	3.7	3.3	2.8	1.6	7.6
All items	15.6	14.5	14.4	12.2	11.3	8.8	8.8	5.3	4.8	6.8	6.7	5.9	5.9	9.3
<u>UK</u>														
Services	22.2	17.2	11.5	5.9	4.7	6.0	5.1	4.1	5.7	6.8	8.3	10.3	7.3	8.9
Goods	14.4	9.6	7.5	4.8	4.4	4.4	2.7	3.2	3.6	4.9	6.7	6.9	3.8	5.9
All items	18.0	11.9	8.6	4.6	5.0	6.0	3.4	4.1	4.9	7.8	9.5	5.8	3.7	7.2

Non-tradable sector is CPI for services less rents; tradable is CPI for goods less food, fuel and light. The UK services and other countries' non-tradables are not directly comparable, because the former includes retail prices of fuel and light.

Note: all items CPI includes food etc and is therefore not equal to the weighted sum of the goods and services definitions used here.

Source: OECD

In the light of the currency movements in September 1992 it is of interest to note that sectoral divergences in inflation have been proportionately lower in the EC core country, Germany, or once inflation convergence has been achieved, as in France, than in Italy, Spain and the UK, which either devalued (Spain) or left the ERM (Italy and the UK).

More specific points to emerge from Table 4.1 and Chart 4.4 are:

(i) There was a steady rise between 1986 and 1991 in relative inflation in the tradable sector in Germany, although this trend was reversed in 1992. (The appreciation of the Deutschmark over this period would, other things equal, have led to a fall in tradable price inflation.)

(ii) The data for France suggest that falling inflation in the tradable sector after 1986 was associated with a smaller and lagged reduction in inflation in the non-tradable sector.

(iii) Since 1986 inflation in the tradable sector in Italy has remained between 5 and 6%. This appears to have been insufficient to put downward pressure on inflation in the non-tradable sector.

(iv) In Spain, prior to 1986 CPI inflation fell gradually while the rates in the non-tradable and tradable sectors were little different. Since 1987 a gradual rise in inflation in the non-tradable sector has occurred, but inflation in the tradable sector has remained relatively subdued at around 5 to 6%.

Chart 4.4 : Consumer prices and consumer price inflation : goods and services

—— consumer price of goods less food and fuel 1980=100.
- - - consumer price of services less rent 1980=100.

—— percentage change on year earlier.
- - - percentage change on year earlier.

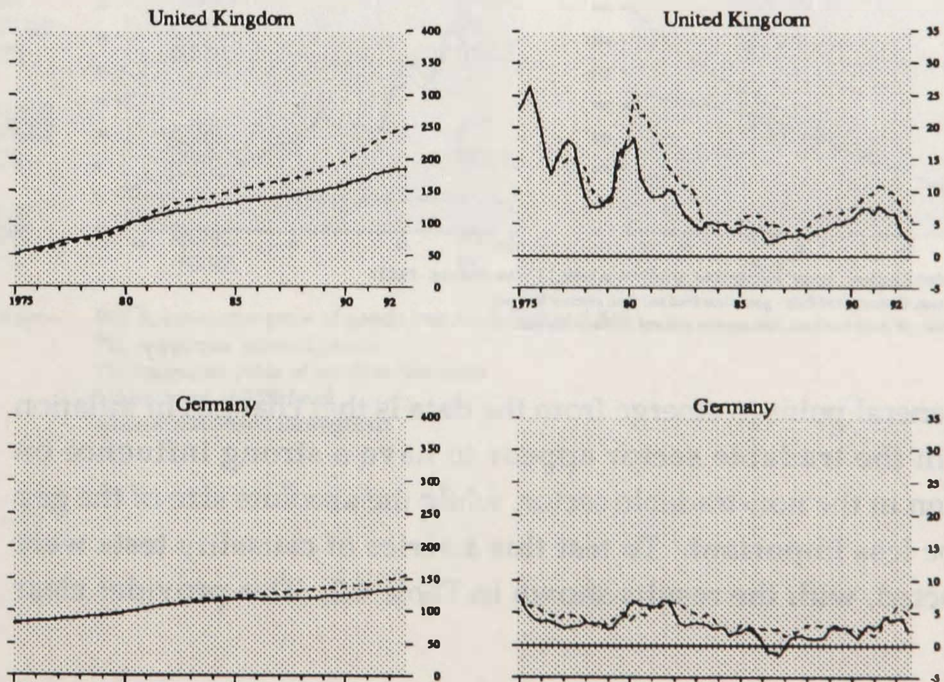
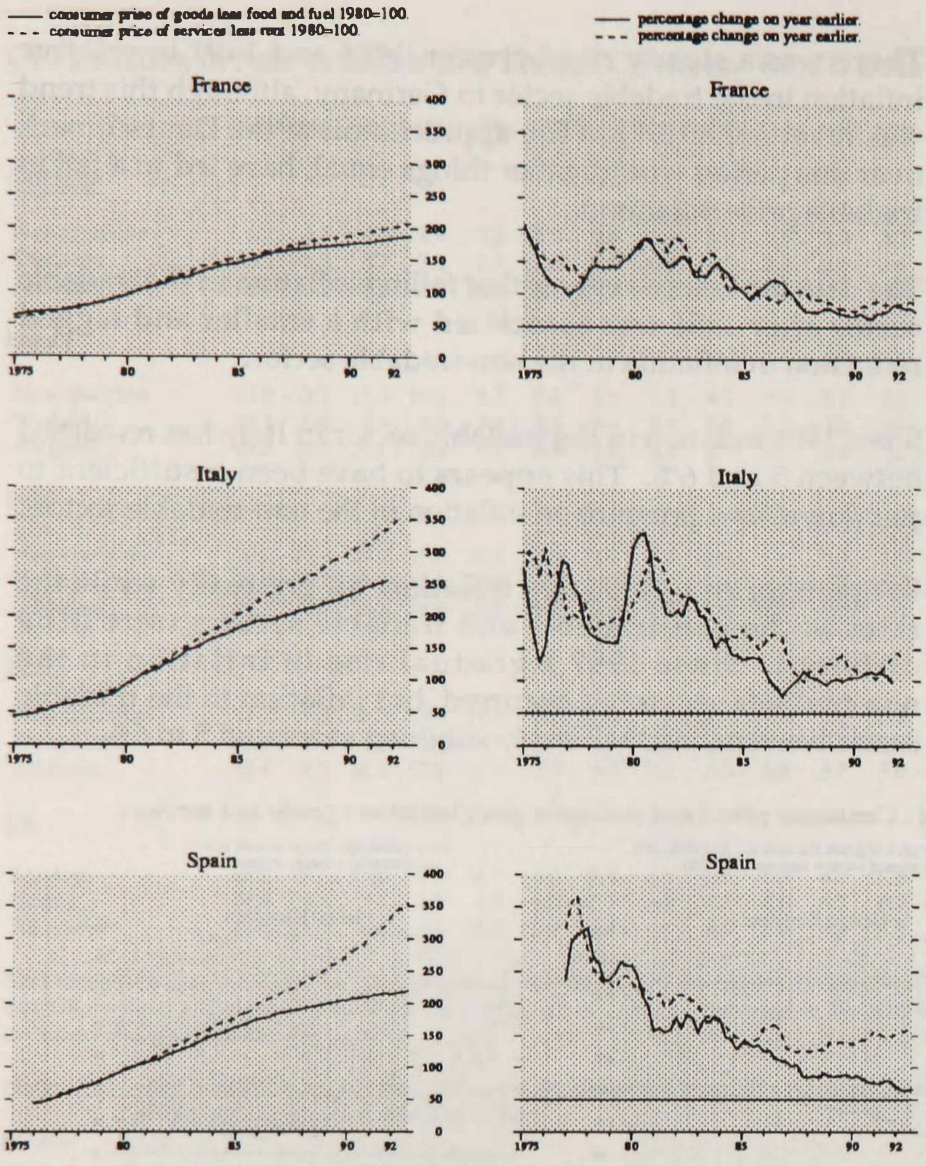


Chart 4.4 : (continued)



Sources : United Kingdom - 'goods' and 'services' as defined in Table 2.1; other countries - OECD.
France, Germany and Italy - goods less food and fuel; services less rent.
Spain - all items less food, fuel, services and rent; services less rent.

One general point to emerge from the data is that changes in inflation rates in the tradable sector appear to have a strong influence on inflation in the non-tradable sector, while the absolute size of the gap may be less important. To test this a series of causality tests were conducted, with the results shown in Table 4.2. This provides clear evidence for Germany, France, Italy and the UK that causality runs from inflation in the tradable or goods sector to the non-tradable or services sector. Spain is the only exception, which is unsurprising given that sectoral prices have diverged only after about 1987.

Table 4.2:

Price Causality Tests

Equation of form $\Delta x = k + \Delta x\text{-}1 + \Delta x\text{-}2 + \Delta y\text{-}1 + \Delta y\text{-}2$

Dependent Variable		Additional Regressors	Tests for restrictions LM(2)
Germany			
PGLF	(65-92)	PS	2.9
PS	(65-92)	PGLF	8.6*
PGLF	(79-92)	PS	0.2
PS	(79-92)	GPGLF	7.5*
France			
PGLF	(63-92)	PS	3.6
PS	(63-92)	PGLF	4.1
PGLF	(79-92)	PS	3.2
PS	(79-92)	PGLF	6.1*
Italy			
PGLF	(66-91)	PS	3.7
PS	(66-91)	PGLF	18.7*
PGLF	(79-91)	PS	0.1
PS	(79-91)	PGLF	6.1*
Spain			
PGLF	(79-92)	PS	3.3
PS	(79-92)	PGLF	1.6
UK			
PG	(80-92)	PS	4.2
PS	(80-92)	PG	10.6*

Key: PGLF, consumer price of goods less food, fuel and light
PG, consumer price of goods
PS, consumer price of services less rents
* significant at 95% level
Annual data used throughout

The estimates for the price wedge shown in section 3 demonstrated that it is possible to explain successfully much of the UK price wedge in terms of macroeconomic variables. To see whether this also applied elsewhere, simple price equations to explain the price wedge in the major 4 EC countries were estimated using annual data from 1981 to 1991. The specification used was of the form:

$$lnPW = k + a_1 lnPRODW + a_2 lnMER + a_3 RRX + a_4 R + a_5 PSBR \tag{4.1}$$

where *PW* is the price wedge (CPI services less rents minus CPI goods less food and fuel); *PRODW* is productivity in non-manufacturing less productivity in manufacturing; *MER* is manufacturing earnings; *RRX* is the real effective exchange rate; *R* is short-term nominal interest rates and *PSBR* is the PSBR to nominal GDP ratio. Equations were estimated in first difference terms and also with *lnCPI* substituted for *lnMER*. The expected signs on the coefficients are $a_1<0$; $a_2<0$; $a_3>0$; $a_4<0$; $a_5>0$.

Table 4.3:

Major European Countries: Price Wedge Equations

Estimation period 1981-1991

Germany

ΔlnPW	=	.017	-	0.16ΔlnRRX	-	0.003R	-	0.005PSBR
		(1.8)		(-1.5)		(-2.4)		(-1.6)

$\bar{R}^2 = 0.37$; SE% = 0.9; DW = 2.2

France

ΔlnPW	=	-0.11	-	0.62ΔlnPRODW	-	1.60ΔlnMER	+	0.02R	+	0.01PSBR

$\bar{R}^2 = 0.50$; SE% = 1.0; DW = 3.0

Italy

ΔlnPW	=	0.20	+	2.41ΔlnCPI	-	0.82ΔlnMER	-	0.22R
		(1.8)		(1.9)		(-1.7)		

$\bar{R}^2 = 0.07$; SE% = 1.7; DW = 2.3

Spain

ΔlnPW	=	-0.28	+	0.63ΔlnCPI	+	0.009T
		(-2.1)		(2.0)		(3.1)

$\bar{R}^2 = 0.51$, SE% = 1.4; DW = 1.0

Selected results are set out in Table 4.3. They are disappointing. In the case of Germany the failure to obtain a satisfactory equation probably reflects the absence of systematic movements in the price wedge and the small divergences in sectoral productivity and earnings. In the case of Italy the productivity wedge was insignificant when included alongside manufacturing earnings. In none of the equations do both the policy variables have the expected signs. For Spain the coefficients on the explanatory variables were poorly determined. Only for Germany is the real exchange rate significant. It is clear from this that analysis with quarterly data and separate estimates for tradable and non-tradable prices is probably required to obtain satisfactory estimates.

5. Summary and Conclusions

The theoretical section of the paper showed how the relative price of tradables and non-tradables may be related to other macroeconomic variables, notably wages, productivity, prices of competing imports and government expenditure. A link was also implied between conventional measures of international competitiveness, relative prices measured in common currency terms, and the relative price of tradables and non-tradables within a country.

Hitherto, empirical work in this area has been hampered by inadequate price series, especially for non-tradables. For this paper, series for tradable and non-tradable prices were derived using RPI data for the UK, and OECD CPI data for four other major EC countries. There is also the problem that any boundary between tradable and non-tradable prices which is based on physical characteristics (good v services) or import penetration ratios is essentially arbitrary. In this paper (Annex 3) a behavioural test has been applied. If the answer to the question 'are non-tradable prices influenced by competing import prices?' is no then those goods and services are non-tradable.

Two important features emerged from analyses of the price data. First, for all the countries except Spain, tradable prices were found to Granger-cause non-tradable prices. Second, measured on a base of 1980, a gap between non-tradable and tradable prices has opened in all five countries, but it is small in Germany and France, and more pronounced in the cases of Italy, Spain and the UK.

Equation estimates using UK quarterly data for non-tradable and tradable prices and the difference between them - the price wedge - were presented for the period 1976 Q1 to 1992 Q2. A two stage procedure was adopted, using the residuals from static cointegrating equations as error correction terms in dynamic second stage equations. The cointegrating equations were estimated by OLS and the Johansen technique, and the dynamic equations by both OLS and instrumented variable. The dynamic equations were largely satisfactory on the basis of the reported econometric tests, and IV estimates were found to be very similar to the corresponding OLS estimates.

In estimating both the OLS cointegrating and dynamic equations, tests were conducted for predictive failure and parameter constancy for the period of UK membership of the ERM. Although the tests are not powerful, there was no evidence of predictive failure, or, for the cointegrating relations, of parameter instability. This implies that the behaviour of tradable and non-tradable price inflation since the peak in the second half of 1990 is consistent with earlier behavioural relationships and can be explained by the paths of the explanatory variables. So while ERM membership may, for example, have allowed a change in the relationship between interest rates and the exchange rate, on the evidence presented here underlying price setting behaviour, essentially the relationship between prices and costs, competitors' prices and monetary policy, was not affected. The estimates suggest that for non-tradables the slowdown in inflation since the peak in 1990 largely reflects the slowdown in the growth of whole economy earnings and faster growth of productivity. For tradables, the slow growth of competing import prices is quantitatively important, enhanced by greater fixity of the exchange rate in this period. Interest rate effects were found for both tradable and non-tradable prices, and capacity utilisation effects for tradables. But their quantitative importance is small.

Dynamic multiplier analysis suggested that on the basis of the estimated equations there is no consistent difference in the speed of response of tradable and non-tradable prices to shocks to the main explanatory variables. Typically full effects occur after about 8 quarters, with over half the effects coming through by about 4 quarters. The response of prices to wages in the non-tradables sector was particularly rapid. These results suggest that the main source of the UK's inflation inertia has come from the cost side rather than price setting mechanism itself.

Using the same estimation approach equations for the price wedge and the aggregate of tradable and non-tradable prices have also been estimated. Formal tests showed that neither was encompassed by the difference or sum of tradable and non-tradable prices. The cointegrating vectors for the price wedge did not fully accord with theoretical priors. But the price wedge approach is of some value in that it confirms that sectoral productivity growth, emphasised by theory, is one of only a number of explanatory factors. On the basis of these estimates it accounted for about one quarter to one third of the trend difference in sectoral prices over the period from 1983 to 1992.

Some simple econometric equations which attempt to explain changes in the price wedge (the difference between tradable and non-tradable prices) for the major European countries have been presented (Table 4.3). There was some evidence that sectoral productivity differences have played a significant role in France, but the evidence was weaker for the other countries considered. Interest rate effects were found for all countries except Spain. However the equations do not give an adequate overall explanation for these countries, suggesting that there are some missing factors. Structural factors such as labour market rigidities and monopolistic behaviour in the non-tradable sector are obvious candidates. Experience with the UK data suggests that separate estimates of tradable and non-tradable prices with quarterly data are likely to be more informative.

References

Alogoskoufis, G (1990), 'Traded Goods, Competitiveness and Aggregate Fluctuations in the UK'. *Economic Journal*, vol 100, pages 141-63.

Alogoskoufis, G (1992), 'Monetary Accommodation, Exchange Rate Regimes and Inflation Persistence'. *Economic Journal*, vol 102, pages 461-80.

Bank of England Quarterly Bulletin (1993), 'Tradable and Non-Tradable Prices in the United Kingdom and the European Community', February 1993, pages 80-91.

Baumol, W J, J Panzar and R D Willig (1982), 'Contestable Markets and the Theory of Industrial Structure'. Harcourt, Brace, Javanovich; New York.

Bayoumi, T and B J Eichengreen (1993), 'Shocking Aspects of European Monetary Unification', in F Torres and F Giavazzi (eds), 'The Transition to Economic and Monetary Union in Europe', Cambridge University Press (forthcoming).

Cambell, J and P Perron (1991), 'Pitfalls and Opportunities: What Macroeconomists should know about Unit Roots'. NBER Macroeconomics Annual.

CSO (1989), 'Import Penetration and Export Sales Ratios for Manufacturing Industry', Business Monitor MQ12. HMSO.

CSO (1991), 'Retail Prices 1914-1990'. HMSO.

De Gregorio, J, A Giovannini and T Krueger (1993), 'The Behaviour of Non-Tradable Goods Prices in Europe: Evidence and Interpretation'. IMF mimeo.

Eichengreen, B and C Wyplosz (1993), 'The Unstable EMS'. *Brookings Papers on Economic Activity* (forthcoming).

Falvey, R E and N Gemmell (1991), 'Explaining Service - Price Differences in International Comparisons'. *American Economic Review*, December 1991, pages 1,295-309.

Giovannini, A (1992), 'Equilibrium Real Exchange Rates.' Paper presented to Bank of Finland - CEPR Conference September.

Granger, C W J and P Newbold (1974), 'Spurious Regression in Econometrics'. *Journal of Econometrics*, vol 2, pages 111-20.

Hall, S G (1989), 'Maximum Likelihood Estimation of Cointegration Vectors: An Example of the Johansen Procedure'. *Oxford Bulletin of Economics and Statistics*, vol 51 pages 213-18.

Hendry, D F (1988), 'The Encompassing Implications of Feedback versus Feedforward Mechanisms in Econometrics'. *Oxford Economic Papers*, vol 40, pages 132-49.

Joyce, M A S (1990), 'The Determination of Average Earnings in Great Britain'. *Bank of England Discussion Paper No 53*.

Layard, P R G and S J Nickell (1986), 'Unemployment in Britain'. *Economica*, vol 53(supplement), pages s121-70.

Layard, P R G, S J Nickell and R Jackman (1991), 'Unemployment: Macroeconomic Performance and the Labour Market'. Oxford: OUP.

Lindbeck, A (1979), 'Imported Structural Inflation and Aggregate Demand: the Scandinavian Model Reconstructed', in A Lindbeck (ed), 'Inflation and Employment in Open Economies', North Holland Publishing.

Martin, C (1992), 'Price Adjustment and Market Structure'. Queen Mary and Westfield College, Department of Economics Paper No 263, May 1992.

Pagan, A R (1984), 'Model Evaluation by Variable Addition', in D F Hendry and K F Wallis, (eds), 'Econometrics and Quantitative Economics', Blackwell.

Price, S (1992), 'Forward Looking Price Setting in UK Manufacturing.' *Economic Journal*, vol 102, pages 497-505.

Rebelo, S (1992), 'Inflation in Fixed Exchange Rate Regimes: The Recent Portugese Experience'. Institute for International Economic Studies, Seminar Paper No 517.

Rowlatt, P A (1988), 'Analysis of the recent path of UK inflation'. *Oxford Bulletin of Economics and Statistics*, vol 50, no 4, pages 335-60.

Taylor, J B (1979), 'Staggered Wage Setting in a Macro Model'. *American Economic Review*, Papers and Proceedings.

Weitzman, M (1982), 'Increasing Returns and the Foundations of Unemployment'. *Economic Journal*, vol 92, pages 787-804.

ANNEX 1: CONSTRUCTION OF RPI SUB-INDICES

Aggregation

The CSO's procedure for weighting together components price indices was applied to the sub-components shown in Table 2.1 to obtain the tradable and non-tradable price indices. Full details of this are set out in 'Retail Prices 1914-1990', CSO (1991). The procedure involves the following steps:

(a) For each component, calculate an index for the current month based on the previous January. This is done by dividing the current month's index by the January index and multiplying by 100.

(b) Calculate a weighted average of these January-based indices, using the current year's weights. (Each year's weights come into use in February and remain current up to and including the following January.)

(c) Convert this January-based aggregate index back to the standard reference base. This is done by multiplying it by the aggregate index for the January in question and dividing by 100.

To show how this procedure works consider the following procedure for constructing an aggregate index with monthly data rebasing each February:

For year 1, working with monthly data and setting January = 100 for all sub-indices we have:

$$X_{1t} = \Sigma(p_{it} \cdot w_{iJan1})$$

where X is the aggregate index
t is the month
p_i is the ith subcomponent
w_i is the weight of the ith subcomponent
T 1 is year 1.

For the year 2 from February to January year 3

$$X_{2t} = X_{1Jan2} . \Sigma(p_{it}/p_{iJan2} . w_{iJan2})$$

ie the weighted sum of the proportionate changes from the January of year 2 is multiplied by the value of the index in January year 2 evaluated using year 1 weights.

For year 3 from February to January year 4 we have

$$X_{3t} = X_{2Jan3} . \Sigma(p_{it}/p_{iJan3} . w_{iJan3})$$

$$= X_{1Jan2} . \Sigma(p_{it}/p_{iJan2} . w_{iJan2}) . \Sigma(p_{it}/p_{iJan3} . w_{iJan3})$$

For each succeeding year the February to January of the next year is calculated on the basis of the index reached by successive substitution through all the preceding years.

Exclusion of tax from alcohol and tobacco sub-indices

The procedure for removing the tax element of the RPI's for alcohol and tobacco was applied separately to each of five sub-indices, beers, wines, spirits, cigarettes and other tobacco products. In each case only the specific duty and the *ad valorem* tax on cigarettes were removed: value added tax, levied on the duty inclusive price, was retained. The published retail price indices first need to be converted to a value series. This was done using the prices for April 1974 set out in Table A1.1.

Having derived a tax inclusive value series for each of the five items, the next step was to remove the excise duty component. This was done by compiling series for the levels of specific duties using the 'Tax and Benefit Reference Manual' compiled by HM Treasury. The details of these are set out in Table A1.2.

The treatment of tax on tobacco products between January 1974 and April 1978 is complicated by the fact that before the budget of April 1976 an import duty was levied on tobacco, while between April 1976 and 1 January 1978 there was a transitional regime involving both import and excise duties. Estimates of total duty paid on a packet of 20 cigarettes made by HM Customs and Excise, shown in Table A1.3, were therefore applied to both cigarettes and tobacco products in this period. This is an approximation since over the transitional period the specific duty on tobacco products was first levied in April 1976, and on cigarettes in March 1977.

The treatment of wines and spirits also involves an approximation. The CSO do not provide separate sub-indices for wines and spirits. To obtain tax-inclusive value series the initial prices in Table A1.1 were applied to the wines and spirits index. From these two series, which have an identical profile through time, the differing duties on wines and spirits were subtracted to provide separate tax exclusive indices for wines and spirits. These were then aggregated to provide a new tax exclusive wines and spirits RPI index, using weights derived from the 1988 Family Expenditure Survey.

The tax inclusive and exclusive price indices for alcohol and tobacco are show in Charts A1.1 and A1.2 below.

Chart A1.1 : Inflation in Alcohol Products

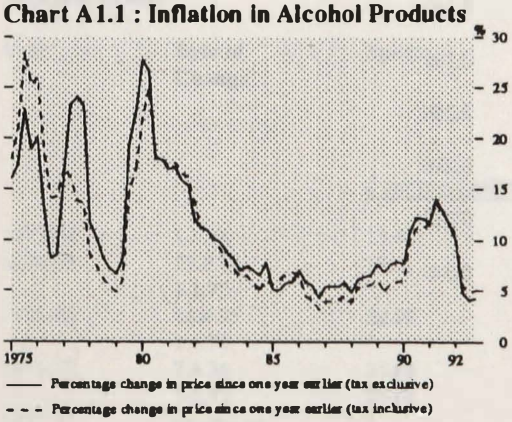


Chart A1.2 : Inflation in Tobacco Products

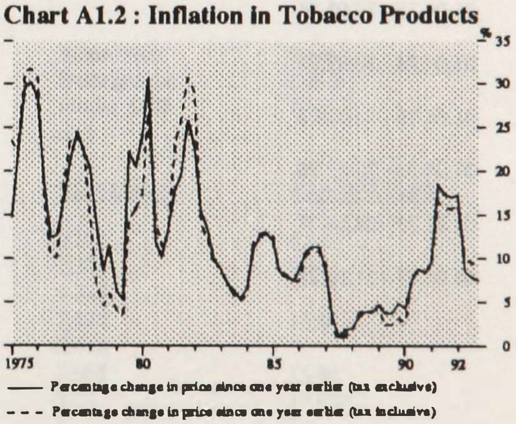


Table A1.1:

Initial Prices

Product	Price in April 1974	Source
Beer (pint or bottle)	£0.221	The CSO
Whisky (75cl)	£2.93	The Scotch Whisky Association
Wine (a bottle)	£0.90	The Wine and Spirits Association of Great Britain
20 Cigarettes	£0.32	The CSO
1oz Pipe Tobacco	£0.4678	The Pipe Smoker's Council

Table A1.3:

Estimates of Total Duty Paid on 20 Cigarettes

Period	Total Duty Paid (£)
01.04.73 - 30.03.74	0.145
01.04.74 - 30.03.75	0.195
01.04.75 - 30.03.76	0.260
01.04.76 - 30.12.76	0.280
01.01.77 - 04.04.77	0.315
05.04.77 - 31.12.78	0.345

Table A1.2:

Specific Duties from 1974

Tobacco Products

Year	Date of Change	Pipe Tobacco £ per lb	Cigarettes Ad Val Rate %	Specific Duty £ per thousand
[NB Duty charged on imports only until April				
1976-77	7.4.76	1.55	20	-
1977-78	30.3.77	1.705	22	1.41
	1.1.78	7.30	30	9
1978-79	no change	"	"	"
1979-80	13.8.79	"	21	11.77
	1.1.80	7.30	21	11.77
		£ per kg	%	£ per thousand
1979-80	1.1.80	16.09	21	11.77
1980-81	26.3.80	17.40	21	13.42
1981-82	10.3.81	21.92	21	18.04
	2.7.81	22.96	21	19.03
1982-83	10.3.82	24.95	21	20.68
1983-84	16.3.83	24.95	21	21.67
1984-85	14.3.84	24.95	21	24.97
1985-86	22.3.85	24.95	21	26.95
1986-87	19.3.86	24.95	21	30.61
1987-88	18.3.87	24.95	21	30.61
1988-89	15.3.88	24.95	21	31.74
1989-90	14.3.89	24.95	21	31.74
1990-91	29.3.90	24.95	21	34.91
1991-92	19.3	28.69	21	40.15

Alcoholic Drinks

Year	Date of Change	Spirits	Wine from fresh grapes (under 15% alc)	Beer (up to 1030.)
		£ per proof gallon	£ per gallon	£ per bulk barrel
1973-74	1.1.74	15.45	0.825	6.90
1974-75	27.3.74	17.01	1.370	9.36
	1.1.75	"	1.345	"
1975-76	16.4.75	22.09	2.675	13.68
	1.1.76	"	2.652	"
1976-77	7.4.76	24.63	2.955	15.84
	1.1.77	27.09	3.25	17.424
1977-78	no change	"	"	"
1978-79	no change	"	"	"
1979-80	-	27.09	3.25	17.424

Table A1.2: (continued)

		£per litre of alcohol	per hecto litre	£ per hecto litre
1979-80	-	10.44	71.49	10.65
1980-81	26.3.80	11.87	81.42	13.05
1981-82	10.3.81	13.60	95.20	18.00
1982-83	10.3.82	14.47	106.80	20.40
1983.84	16.03.83	15.19	113.00	21.60
1984-85	14.03.84	15.48	90.50	24.00
1985-86	20.3.85	15.77	98.00	25.80
1986-87	no change	"	"	"
1987-88	no change	"	"	"
1988-89	15.3.88	15.77	102.40	27.00
1989-90	no change	"	"	"
1990-91	20.3.90	17.35	110.28	29.10
1991-92	19.3.91	18.96	120.54	31.80

ANNEX 2: CAUSALITY TESTS

Granger causality tests were conducted by estimating equations of the following general form:

$$\Delta x = k + \Delta x_{-1} + \ldots + \Delta x_{-i} + \Delta y_{-1} + \ldots + \Delta y_{-i} \qquad (2.1)$$

These were re-estimated excluding terms in Δy, and the significance of the exclusion restriction tested. Lags to -4 were included. Since the unit root tests had shown that most of the variables were I(1), regressions were specified in first differences to reduce the likelihood of spurious results due to common trends. Where the exclusion restriction was significant the regression was re-estimated with Δy as the dependent variable. In cases where Δy was significant in the Δx equation, but not Δx in the Δy equation, Granger causality of y on x is established. Results are shown in Tables A2.1 and A2.2 for set A. Similar results were obtained with set B. These results are of interest to detect dynamic inter-relationships; they are also helpful in deciding what variables to include in the long-run cointegrating vectors, although some of the results conflicted with theoretical priors and were not confirmed by estimates of the cointegrating vectors.

Table A2.1:

Variable Deletion Tests[1]

Sample period 1975Q2-1992Q2

Equation	Additional Regressors	Tests for Restrictions F4,60	Granger Cause
Non-tradable			
(i)	ΔlnAT	6.5*	√
(ii)	ΔlnULC	15.6*	√
(iii)	ΔlnUHMN	1.4	-
(iv)	ΔlnPMGN	2.4**	√
(v)	ΔlnPPI	3.1*	X
(vi)	ΔlnETDE	19.8*	X
(vii)	ΔlnOHRE	2.3**	X
(viii)	ΔlnOPEW	2.2**	√
(ix)	ΔNNOR2	3.6*	√
(x)	ΔCBI	4.8*	√
(xi)	ΔRRS	1.4	-
(xii)	ΔSTIR	1.7	-
(xiii)	ΔPSBRRAT[1]	3.0*	√
(xiv)	ΔlnGGS	2.7*	√

Equation	Additional Regressors	Tests for Restrictions F4,60	Granger Cause
<u>Tradable</u>			
(xv)	ΔlnANT	0.6	-
(xvi)	ΔlnULCM	2.5**	X
(xvii)	ΔlnUHMN	0.7	-
(xviii)	ΔlnPMGN	3.6*	√
(x)	ΔlnPPI	3.4*	√
(xx)	ΔlnEMAN	0.9	-
(xxi)	ΔlnOPEM	4.9*	X
(xxii)	ΔNNOR2	3.9*	√
(xxiii)	ΔCBI	2.5**	√
(xxiv)	ΔRRS	2.6**	√
(xxv)	ΔSTIR	1.5	-
(xxvi)	ΔlnPSBRRAT(2)	0.0	-
(xxvii)	ΔlnRULC	0.0	-
(xxviii)	ΔlnEER	0.7	-
(xxix)	ΔlnWPOS	0.3	-
(xxx)	ΔlnGGS	0.3	-

(1) See Table 2.3 for variable definitions. √ indicates Granger causality, χ a significant two-way relationship.
(2) Equation estimated with seasonal dummies.
* significant at 95% level; critical (95%) value for F4, 59 = 2.55;
** significant at 90% level.

Results which are of interest in Table A2.1 include:

(i) evidence that tradable prices Granger cause non-tradable prices, equations (i) and (xv). This result may be interpreted as showing that domestic inflation is influenced by shocks from overseas via tradable prices. This effect is independent of commodity price effects as measured by producer input prices, where Granger causality was not established for non-tradables, equation (v);

(ii) whole economy productivity Granger causes non-tradable prices, equation (viii). Manufacturing productivity is significant in the tradable price equation (xxi) but does not Granger cause;

(iii) whole economy earnings were found to be highly significant in the non-tradable price equation, equation (vi), but there was two way causation. Neither whole economy average wages and salaries (not reported) nor manufacturing earnings, equation (xx), were significant in the tradable price equation. Unit labour costs in manufacturing do not Granger cause tradable prices, equation (xvi);

(iv) the results for import prices and competitiveness were found to be sensitive to the definition used. Surprisingly, the import UVI for manufacturers less ships, aircraft etc, equation (xvii), was insignificant in the tradable price equation. However, the price deflator for non-oil goods was found to Granger cause both tradable and non-tradable prices, (iv) and (xviii) respectively. Competitiveness, as measured by relative unit labour costs and the exchange rate, were not significant in equations for tradable prices, (xxvii and xxviii);

(v) producers input prices were found to Granger cause tradable, but not non-tradable, prices, equations (xix) and (v) respectively;

(vi) real short-term interest rates Granger cause tradable prices only, equation (xxiv). Nominal interest rates were significant for neither price series. The PSBR to GDP ratio was found to Granger cause non-tradable prices (xiii);

(vii) the CBI capacity utilisation measure and the residual from a regression of non-oil output on a split period time trend both Granger cause both price series. The significant result for non-tradables for the CBI measure is surprising, given the coverage of the survey;

(viii) government consumption of goods and services was found to Granger cause non-tradable prices, (xiv). It was insignificant in tradable prices.

The causality tests for the price wedge are presented in Table A2.2. The results generally reflect those for the separate tradable and non-tradable price series. Thus whole economy earnings, and capacity utilisation were found to Granger cause. Tradable, but not non-tradable, prices Granger cause the price wedge. One surprising feature was the insignificance of the productivity difference variables. As regression analysis shows, this may be because the causality test, being in first difference terms are capturing short run effects. In the cointegrating relationships the price and productivity wedges are found to be strongly related. None of the policy variables were found to Granger cause the price wedge, although real interest rates and the PSBR ratio were both significant.

Table A2.2:

Causality (variable deletion) tests for the price wedge

Sample period 1975 Q1-1992 Q2

	Additional Regressors	Tests for Restrictions F4,60	Granger Cause
(iii)	ΔlnAT	4.9*	√
(iv)	ΔlnANT	4.9*	X
(v)	ΔlnUHMN	1.0	-
(vi)	ΔlnOPD	1.5	-
(vii)	ΔRRS	9.4*	X
(viii)	ΔSTIR	0.8	-
(ix)	ΔPSBRRAT	2.1**	X
(x)	ΔlnEER	1.4	-
(xi)	ΔlnEDMS	0.9	-
(xii)	ΔRULC	2.2**	X
(xiii)	ΔlnPPI	0.8	-
(xvi)	ΔCBI	8.4*	√
(xvii)	ΔNNOR2	2.1**	√
(xviii)	ΔlnULCM	6.2*	X
(xix)	ΔlnETDE	12.2*	√
(xx)	ΔlnPMGN	0.8	-
(xxi)	ΔlnGGS	9.8*	X
(xxii)	ΔlnWPOS	1.0	-

* significant at 95% level; critical (95%) value F4, 60 = 2.57

** significant at 90%

ANNEX 3: ESTIMATION RESULTS WITH AN ALTERNATIVE DEFINITION OF NON-TRADABLE AND TRADABLE PRICES

In this Annex the estimation results using set B definitions for non-tradable and tradable prices and the price wedge are presented. The difference between these and set A is that food, drink and tobacco prices are switched from tradable to non-tradable sectors. The weight of tradable prices falls, from 67% to 40% of the total in 1992, with a corresponding rise in the proportion of non-tradables, see Table 2.1. The congruence between tradables and the output of and trade in manufactures is thereby weakened. There is also evidence that on the set B definition non-tradable prices are influenced by competing import prices. For these reasons estimation results may be less satisfactory than with set A.

Non-Tradable Prices

The cointegrating equations are shown in Table A3.1. The reported OLS equation was obtained by re-estimating the preferred specification for set A non-tradable prices and excluding the insignificant term in government expenditure, ($F_{1,62}=0.43$). As with the set A definition the coefficient on producer input prices is larger than might be expected. The coefficient on short term interest rates is highly significant. (Since STIR is a borderline I(0)/I(1) variable over this sample the possibility of a 'spurious regression' arises.) As with set A data no capacity utilisation effects could be found. The reported Johansen equation, equation B, is not consistent with the OLS estimate. OLS equation is stable over the period from 1990 Q2, on both the dummy variable and predictive failure tests.

To examine whether competing import prices are orthogonal to the set B definition of non-tradable prices, as implied by theory, a version of the OLS cointegrating equation including import prices of manufactures was estimated (not reported). Import prices were found to be highly significant (LM test for variable addition: $\chi_1^2 = 6.4$). When the same variable was added to the corresponding set A OLS cointegrating equation (equation A, Table 3.1), the test statistic was close to zero ($\chi_1^2 = 0.00008$). This is quite strong evidence that the import price and tradable price definitions are more congruent with set A, a result reinforced by the difficulty described below in obtaining estimates of the price wedge equation with set B. However, it has not been possible in the present work to test for possible effects on services prices of overseas competition. This is essentially because many 'tradable' services, eg financial services, lie outside the retail sector.

Table A3.1:

Cointegrating equations for non-tradable prices

lnBNT	A	B
k	1.42	
	(25.6)	
lnETDE	0.80	1.05
	(35.4)	-
lnOPEW	-0.61	-1.40
	(-7.1)	
lnPPI	0.38	0.04
	(18.1)	-
STIR	-0.0081	I(0)
	(-8.7)	
TS	0.0012	I(0)
	(4.1)	-
$\bar{R}^2$	0.999	-
SE%	1.53	-
LM(4)(1)	3.1	-
LM(8)(2)	3.1	-
Estimation Period	75Q2-92Q2	75Q3-92Q2
Estimation method	OLS	Johansen

(1) LM test of parameter stability 1990Q3-1992Q2.
(2) LM test of adequacy of predictions 1990Q3-1992Q2.

The dynamic equations reported in Table A3.2 fit the data well. (No IV estimate is reported in the absence of contemporaneous explanatory variables.) Both reported equations are acceptable on econometric grounds, although the null of homoskedastic residuals can be rejected at the 90% level with both equations. There is no indication of predictive failure. The coefficients on the LDV and error correction terms indicate a high degree of nominal inertia and slow response to disequilibrium in the equations. This is in contrast to the set A dynamic equations, and reinforces the evidence that the estimated cointegrating vectors may not be a good representation of equilibrium prices.

Table A3.2:

Dynamic equations: non-tradable prices

ΔlnBNT	(I) OLS	(II) Johansen
k	0.0038	0.12
	(2.2)	(2.7)
ΔlnBNT(-1)	0.46	0.37
	(7.4)	(5.1)
ΔlnETDE(-2)	0.23	0.25
	(2.9)	(3.4)
ΔlnOPEW(-2)	-0.23	-0.26
	(-3.4)	(-4.1)
ΔlnPPI(-1)	0.15	0.13
	(6.1)	(5.3)
D79Q3	0.043	0.041
	(8.4)	(4.4)
D91Q2	0.023	0.021
	(4.4)	(4.4)
RES1(-3)(1)	-0.088	-0.041
	(-2.0)	(-2.7)
$\bar{R}^2$	0.85	0.87
SE%	0.50	0.47
LM(4)	2.7	4.3
RESET	1.2	8.6*
NORM	0.1	1.3
HETERO	5.1*	2.7**
LM(11)	12.1	-
PRED(2)	3.0	-
Estimation period	76Q1-92Q2	76Q2-92Q2

(1) Equation (i) uses residuals from equation A, equation (ii) residuals from equation B Table A3.1.
(2) Test of adequacy of prediction 1990Q3-1992Q2.
* significant at the 95% level
** significant at the 90% level

Tradable Prices

Equation A of Table A3.3 is the preferred representation of equilibrium tradable prices. It is similar to the corresponding equation with set A data, although there is a significant producer price effect with set B data. An equivalent Johansen estimate, treating real interest rates (RRS) as an I(0) variable and without sterling oil prices, could be obtained, but was found unsatisfactory as an error correction term. The preferred Johansen estimate, equation B, has a negative sign on oil prices, and a coefficient on input prices which is higher than expected.

Table A3.3:

Co-integrating Equations for Tradable Prices

lnBT	A	B
k	0.75	-
	(11.0)	
lnULCM	0.61	0.47
	(29.4)	
lnUHMN	0.35	0.17
	(14.6)	
lnPPI	0.13	0.53
	(3.8)	
RRS	-0.0039	I(0)
	(-5.9)	
D79Q3	0.043	I(0)
	(3.1)	
lnWPOS	-	-0.053
CBI	-	I(0)
$\bar{R}^2$	0.998	-
SE%	1.36	-
LM(4)(1)	3.1	-
LM(8)(2)	9.9	-
Estimation period	75Q2-92Q2	75Q3-92Q1

(1) LM test of parameter stability 1990Q3-1992Q2.
(2) Test of adequacy of predictions 1990Q3-1992Q2.

The same dynamic specification was found to be appropriate for both the OLS and Johansen cointegrating vector, with the results reported in Table A3.4. Some of the individual parameter estimates do not have the expected sign - lagged import and sterling oil prices - and the coefficient on the Johansen error correction term is small and on the border for significance. Moreover, with the estimated parameters (excluding dummies) the specification is not parsimonious, although further exclusions were rejected by the data. The reported equations are free from serial correlation and heteroskedasticity on the basis of the reported test statistics. When re-estimated to 1990 Q2 and used to forecast the subsequent eight quarters, the Chow test for predictive failure is significant at about the 80% level in both equations (i) and (iii) of Table A3.4. On average both equations underpredict. A comparison of equation (i) in with the corresponding dynamic equation with set A data (Table 3.4 equation (i)), shows that the error correction term is larger and enters at lag 1 rather than lag 3 with set B. This indicates that the response to a disturbance from equilibrium is faster with the set B definition. Since this excludes prices of food, drink and tobacco it implies that these prices behave more sluggishly than those of other tradable prices.

The evidence presented here suggests, firstly, that prices of food, drink and tobacco are influenced by prices of competing imports, so that they are properly treated as tradables. But, secondly, that these prices have a different dynamic response to shocks to other tradable prices, which weakens the error correction properties of the set A dynamic equations; the coefficient on the ecm is about twice as large with set B equations.

Table A3.4:

Dynamic Equations Tradable Prices

ΔlnBT	(I) OLS	(II) IV[5]	(III) Johansen
k	0.0039	0.0043	0.039
	(3.0)	(3.1)	(2.3)
ΔlnBT(-2)	0.28	0.26	0.29
	(4.1)	(3.5)	(3.9)
ΔlnULCM[1]	0.16	0.15	0.19
	(2.7)	(2.2)	(3.0)
ΔlnPPI(-1)	0.09	0.09	0.10
	(2.8)	(2.8)	(3.2)
ΔlnPPI(-2)	0.28	0.27	0.28
	(6.5)	(6.0)	(6.2)
ΔlnUHMN(-2)	-0.15	-0.13	-0.12
	(-3.1)	(-2.6)	(-2.4)
ΔlnWPOS	0.02	0.02	0.02
	(3.2)	(3.6)	(2.8)
ΔlnWPOS(-2)	-0.03	-0.03	-0.03
	(-4.2)	(-3.2)	(-4.0)
ΔΔCBI(-1)	-0.0005	-0.0005	-0.0005
	(-3.2)	(-2.2)	(-3.6)
ΔΔRRS[2]	-0.0013	-0.0010	-0.001
	(-4.1)	(-2.5)	(-2.7)
D79Q2	0.048	0.049	0.044
	(7.1)	(7.1)	(6.3)
D78Q2	0.024	0.022	0.026
	(3.7)	(3.3)	(3.9)
D91Q2	0.026	0.024	0.029
	(3.9)	(3.6)	(4.4)
RES(-1)	-0.20	-0.21	-0.075
	(-3.0)	(-3.0)	(-2.0)
$\bar{R}^2$	0.85	0.84	0.84
SE%	0.59	0.60	0.61
LM(4)	5.7	7.0	4.1
RESET	2.1	4.4*	1.7
NORM	1.1	0.6	1.3
HETERO	1.3	0.9	0.9
LM(8)[3]	9.3	-	-
LM(8)[4]	11.1	-	11.0

(1) (ΔlnULCM + ΔlnULCM(-2))/2.
(2) ΔRRS -ΔRRS(-2).
(3) LM test against general form.
(4) Test of predictive failure 1990Q3-1992Q2.
(5) Instruments used: ΔlnWPOD, ΔlnWPOD(-1), ΔlnWPOD(-2), ΔlnULCM(-1), ΔlnULCM(-2), ΔlnULCM(-3), ΔSTIR, ΔRRS(-1), ΔRRS(-2), ΔRRS(-3).
* Significant at 95% level

Price Wedge

The OLS estimates of the cointegrating equation for the price wedge have a number of unsatisfactory features. The coefficients on the earnings difference variable, government expenditure, producer and oil prices were all insignificant. Of more concern is that overseas competitors' prices, as measured by the import price of manufactures, is positively signed, Table A3.5, equation A. Moreover this result does not appear to be sensitive to the measure of competitiveness chosen: relative unit labour costs, the nominal effective exchange rate and import prices of all non-oil goods gave similar results. Estimating the equation over alternative time periods showed that the perverse import price effect is strongest in the second half of the 1970s, when the difference in the profiles of the set A and set B measures of the price wedge is greatest. The inclusion of a time trend in the equation does not affect the overall result.(16) In the absence of a better result, the residual from equation A, Table A3.5, provides the error correction term in the OLS and IV dynamic equations in Table A3.6, despite an incorrectly signed term in import prices. To constrain this coefficient to zero is strongly rejected by the data. The term on the productivity difference is well-determined in this equation. It implies an elasticity of 0.2.

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(16) The finding that lnUHMN is significant in the set B non-tradables cointegrating is relevant to this result. However it should be noted that the coefficient in the non-tradables equation (0.14) is smaller than in the tradables equation (0.17), implying that a small negative coefficient in the price wedge equation is still to be expected.

Table A3.5:

Cointegrating equations for price wedge

	A	B
lnB		
k	-0.95	-
	(-12.6)	-
lnOPD	0.20	0.096
	(6.9)	
lnETDE	0.12	0.30
	(6.3)	-
ln UHMN	0.14	-0.37
	(4.3)	-
CBI	-0.0007	-0.0007
	(4.6)	-
D79 Q3	-0.032	I(0)
	(-2.3)	
$\bar{R}^2$	0.986	-
SE %	1.31	-
LM(4)[1]	9.5*	
LM(8)[2]	2.7	

(1) LM test of parameter stability 1990Q3-1992Q2. significant at the 95% level.
(2) Test of predictive failure 1990Q3-1992Q2.

The dynamic equations presented in Table A3.6 fit the data only moderately. There is evidence of residual serial correlation, although only in equation (ii) is the LM(4) test significant at the 90% level. Equation (i) shows predictive failure at the 87% level, but the mean prediction error is close to zero. Interestingly, the dynamic terms in import prices attract a negative sign in equation (iii), consistent with the results of the Johansen cointegrating equation which is used as the ecm term.

Table A3.6:

Price wedge dynamic equation

ΔlnB	OLS (i)	IV (ii)	Johansen (iii)	
k	0.0037	0.0049	K	0.093
	(3.2)	(3.2)		(4.2)
ΔlnB(-2)	0.22	0.29	ΔlnB(-1)	0.25
	(2.1)	(2.4)		(-2.3)
ΔlnOPD	0.090	0.081	ΔlnB(-2)	0.16
	(1.9)	(1.6)		(1.5)
ΔΔlnETDE(-1)	-0.20	-0.20	ΔlnETDE	-0.23
	(-1.9)	(-1.8)		(-1.5)
ΔlnUHMN(-1)	0.062	-0.052	ΔlnETDE(-1)	-0.26
	(1.3)	(-0.5)		(1.7)
ΔΔCBI(-1)	0.0006	0.0006	ΔlnUHMN	-0.08
	(2.9)	(2.9)		(-1.6)
ΔSTIR	-0.0016	-0.0007	ΔCBI	0.0005
	(-2.1)	(-0.7)		(2.0)
D79Q3	-0.014	-0.016	ΔCBI(-1)	0.0009
	(-1.7)	(-1.9)		(3.3)
D91Q2	-0.0090	-0.0060	Δ79Q3	-0.018
	(-1.2)	(-0.7)		(2.1)
RES(-1)(1)	-0.34	-0.31	RES(-1)	-0.13
	(-4.4)	(-3.7)		(-4.0)
$\bar{R}^2$	0.44	0.38		0.36
SE%	0.71	0.74		0.76
LM(4)	7.4	8.5**		6.5
RESET	2.3	0.17		0.53
NORM	0.8	1.6		0.22
HETERO	0.01	0.20		0.04
LM(8)(2)	7.1	-		-
LM(8)(3)	12.5			

(1) Equations (i) and (ii) use residuals from equation A and equation (iii) uses residuals from equation B, Table A3.5.
(2) LM test against general form.
(3) Test for adequacy of prediction 1990Q3-1992Q2.
** Significant at the 90% level

ANNEX 4: AGGREGATE RETAIL PRICES

A logical extension of the work on tradable and non-tradable retail prices is to estimate equations for their sum, the series RPIA. This covers 80% of the total RPI, with the main exclusions being local authority rates and its successors, mortgage interest payments, seasonal foods and taxes on food, drink and tobacco; Table 2.1 gives details. These exclusions are similar to those made in the main behavioural equation for retail prices in many UK macroeconometric models.

The specification for the equilibrium level of RPIA is obtained by summation of equations 3.1 and 3.2 to give:

$$lnRPIA = d_0+d_1 lnOP+d_2 lnW+d_3 lnPPI+d_4 lnPM+d_5 CAP \qquad \textbf{(A4.1)}$$

where the OP is whole economy output per head and other variables are as defined in section 3. Government expenditure has been excluded since its main influence at the aggregate level is assumed to be reflected in capacity utilisation.

An estimate of equation A4.1 is shown as equation A in Table A4.1. Short-term interest rates were also included since they are highly significant in the long-run equation for non-tradable prices (Table 3.1). The restriction that the coefficient on earnings is equal and of opposite sign is not data acceptable (χ^2_1=9.1) but an estimate, equation B, with this restriction imposed has a standard error only 60% of that of equation A. Homogeneity with respect to labour and input costs is data acceptable in equation A (t ratio of 0.3).(17) In the case of equation B the sum of the coefficients on unit labour costs and input prices is 0.94, but a unit restriction is not data acceptable. Equation B has parameter stability on the basis of the dummy variable test for a break in sample at 1990 Q2, and there is no evidence of predictive failure. Equation C of Table A4.1 is the Johansen estimate corresponding to equation B: the

(17) Restriction that coefficients $d_1+d_2+d_3=0$.

increase in the coefficient on import prices is a notable feature, although the usual caveat about this being only one of a set of cointegrating vectors - of three in this case - applies.

Table A4.1:

Cointegrating Equations for Aggregate Retail Prices

ΔlnRPIA	A	B	C
k	1.72	4.80	-
	(20.4)	(41.3)	
lnETDE	0.76	-	-
	(24.4)		
lnOPEW	-1.08	-	-
	(-8.5)		
lnULC	-	0.76	0.67
		(44.7)	-
lnPPI	0.37	0.18	0.23
	(10.1)	(8.6)	-
lnUHMN	0.10	0.13	0.24
	(1.6)	(4.7)	-
NNOR2	0.21	0.10	0.01
	(2.0)	(1.9)	-
STIR	-0.0068	-0.0047	I(0)
	(-5.5)	(-7.2)	
D79Q3	0.049	0.027	I(0)
	(2.9)	(2.5)	
$\bar{R}^2$	0.998	0.999	-
SE%	1.66	1.04	-
LM(5)(1)	4.8	3.9	-
LM(8)(2)	4.3	5.6	-
Estimation method	OLS	OLS	Johansen
Estimation period	75Q2-92Q2	75Q2-92Q2	75Q3-92Q2

(1) Test for exclusion of dummy variables.
(2) Test for predictive failure 1990Q3-1992Q2.

The preferred dynamic equations using the residuals from equations B and C of Table A4.1 are shown in Table A4.2. These were obtained after removing insignificant terms from a general equation. Noteworthy features are the absence of lagged dependent variables, which features in the dynamic equation for tradable prices, and the prevalence of terms at lag minus 2. The ecm terms enter at lag 3, and are highly significant. In the OLS case, equation (i), most of any departure from equilibrium is resolved after 7 quarters, including the three quarters' start delay. Both reported dynamic equations fit the data well, with standard errors of about 0.5. With the exception of the test for functional form in equation (ii), the equations are acceptable on the basis of the usual tests. There is no indication of significant predictive failure with equation (i), although prediction errors are negative on average.

Table A4.2:

Dynamic Equations for Aggregate Retail Prices

ΔlnRPIA	(i) OLS		(ii) Johansen
k	0.0049		0.62
	(3.9)		(3.3)
ΔlnULC(-2)	0.46		0.50
	(9.4)		(9.2)
ΔlnPPI(-1)	0.096		0.15
	(3.5)		(4.7)
ΔlnPPI(-2)	0.11		0.12
	(3.2)		(3.3)
ΔlnUHMN(-2)	0.049		0.096
	(1.2)		(2.3)
ΔSTIR(-2)	-0.0014		-0.0014
	(-2.7)		(-2.6)
ΔNNOR2(-2)	0.26		0.36
	(3.3)		(4.3)
D79Q3	0.046		0.047
	(8.3)		(8.2)
D91Q2	0.028		0.028
	(5.1)		(4.9)
RES1(-3)[1]	-0.33	RES2(-3)	-0.15
	(-4.6)		(-3.3)
$\bar{R}^2$	0.84		0.83
SE%	0.52		0.54
LM(4)	4.4		2.9
RESET	2.3		9.1*
NORM	1.4		2.3
HETERO	0.2		0.2
LM(11)[2]	13.0		-
LM(8)[3]	7.0		-

(1) RES1 residuals from equation B table A5.1, RES2 residuals from equation C Table A5.1.
(2) Test of exclusions against general form.
(3) Test of adequacy of prediction 1990Q3-1992Q2.
* Significant at 95% level.
Estimation period 1976Q1-1992Q2

Encompassing Tests

A comparison of an aggregate equation with the sum of tradables plus non-tradables is of some interest, especially as aggregate retail prices and tradable prices, set A, are highly correlated in first difference terms.(18) The results of encompassing tests of the aggregate equation against the disaggregated are presented in Table A4.3.

Table A4.3:

Encompassing Test for Tradables plus Non-Tradables

Dependent Variable	Explanatory	Variables		
	k	$\Delta lnRPIA_p$	$\Delta lnDIS_p$	
$\Delta lnRPIA$	-0.0013	0.45	0.30	(i)
	(-1.3)	(3.5)	(4.6)	
$\Delta lnRPIA_r$	-0.0014	-	0.034	(ii)
	(-1.2)		(1.4)	
$\Delta lnDIS_r$	-0.0019	0.10	-	(iii)
	(-1.0)	(1.2)		

Estimation period: 1976Q1-1992Q2

$\Delta lnRPIA_p$ = Predicted value from equation (i), Table A4.2.

$\Delta lnDIS_p$ = Predicted values of tradables plus non-tradables equation, Table 3.2 equation (i) plus Table 3.4 equation (i).

$\Delta lnDIS_r$ = equation residuals from Table 3.2 equation (i) plus Table 3.4 equation (i).

These results, like those for the price wedge, show that neither the aggregate or disaggregated RPI equations encompasses the other. This result is not surprising in view of the way that the specification used for the aggregate RPIA equation was derived.

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(18) The correlation coefficient between $\Delta lnRPIA$ and $\Delta lnAT$ is 0.98 over the sample 1975 Q2 to 1992 Q2.

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