Bank of England

Discussion Paper No.8

The interrelationships between costs and prices in the United Kingdom

by

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C.A.Enoch

and

P.D.Mortimer-Lee

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The object of this series is to give a wider circulation to research work being undertaken in the Bank and to invite comment upon it; and any comments should be sent to the authors at the address given below. The views expressed are theirs, and not necessarily those of the Bank of England.

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Introduction

1 The specification and estimation of cost/price interrelationships and the impact of exchange rate changes on them have been the subject of extensive research, especially in the 1970s when exchange rate flexibility has become widespread. This paper[1] reviews the theoretical and empirical literature on this subject, primarily in a UK context. It considers the role of foreign prices and the exchange rate in the determination of import, export and domestic prices, as well as the role of prices in the determination of wages and the interaction between these various elements. A distinction between short-term and long-term effects is made by considering the various lags involved. The possibilities of changes in the lag structures over time and in the relative weights attributed to the principal determinants are also discussed. Finally, the results of simulations showing the impact of an exchange rate change on the price/wage nexus are reported.

2 The structure of the paper is based on a simple model of the cost/price system described in Section 2. In Section 3 the determination of import and export prices is examined, and in particular the relative influence of domestic and foreign prices and the lags involved before the long-run properties of the equations are established. Import and export prices are tackled first because it is probable that it is in this area that the impact of an exchange rate change is first felt. Section 4 considers the determination of domestic prices. The rather tenuous evidence on the relationship between earnings and prices is reviewed in Section 5, again with special emphasis on the impact of exchange rate changes. Section 6 discusses simulations of the cost/price system, using both the simple model of Section 2 and the Bank short-term model. These models, to a greater or lesser extent, incorporate the rather complex feedback effects which arise when the system is subjected to an exogenous shock, for example an exchange rate change. Conclusions are presented in Section 7.

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[1] The paper was initially prepared for the January 1979 meeting of the Bank's Panel of Academic Consultants. The authors are indebted to L.A.Dicks-Mireaux, B.C.Hilliard and members of the panel for helpful comments on the initial paper.

A simple model of the cost/price system

3 An exchange rate change has many influences on domestic costs and prices. It is possible to summarise the more important of these by considering a simplified model of the cost/price system. In so doing, the key factors which influence the extent to which an exchange rate change results in offsetting cost and price changes, for example, can be isolated for further consideration. The following system of equations represents such a model:

$$PX = \alpha PF + (1-\alpha) PD \quad (1)$$

$$PM = \beta PF + (1-\beta) PD \quad (2)$$

$$PD = \gamma W + (1-\gamma) PM \quad (3)$$

$$W = \delta PD \quad (4)$$

where PX, PM and PD are indices of export, import and domestic prices, respectively, PF is an index of world prices expressed in sterling, and W is an index of nominal average earnings.[1] All equations are linear in logarithms. This particular system assumes that the homogeneity constraint holds in the price equations and that the prices of primary products relative to those of finished goods are constant. It further assumes that the same index of world prices is appropriate to both export and import price determination. Lags are ignored at this stage: only the equilibrium properties are examined.[2]

4 In the model presented above, export and import prices are influenced by prices in both foreign and home markets. Domestic prices are determined as a constant percentage mark-up over variable costs (including import costs) while average earnings depend upon

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[1] In some studies PF replaces PM in equation 3; in addition, a domestic cost variable sometimes replaces the domestic price variable in equation 1.

[2] Most of these assumptions, which are made to simplify the algebra underlying paragraph 6, are relaxed in subsequent sections of the paper, including that reporting the Bank model simulation results.

domestic prices.[1] Most economists would probably accept this model as representing the essence of the price/wage nexus, though the exact specification of the equations and relative size of the coefficients are controversial. It should be mentioned at the outset that a pricing model similar to that discussed in this paper has been advocated for monetarist as well as other models.[2] Hardly any empirical work has been done testing such monetarist models for the United Kingdom, and so results reported in this paper represent the majority of the work done on UK price equations even though no monetarist studies are reported.[3]

5 The initial effect of a depreciation of sterling, for example, would be to raise import prices in sterling terms, probably by almost the full amount of the devaluation (because changes in UK demand have little influence on world prices of most imported goods) and with relatively little delay. The initial impact on export prices may be less strong; indeed, in the very short term, UK export prices may rise only to the extent that exports are invoiced in foreign currencies. Over time, however, export prices can be expected to react further to the exchange rate change. The prices of more exports may be increased in the light of the rise in the sterling equivalent of world prices. Also, domestic costs and prices will increase because of the depreciation and thus, to the extent that they influence export prices, will tend to raise the latter. Domestic prices will react to both the higher cost of imported supplies and the opportunities afforded to domestic producers to increase the prices of import-competing products.[4] Furthermore, the rise in domestic prices - or even depreciation per se - may cause expectations about the future rate of price inflation to be revised upwards, with consequent pressure on

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[1] Productivity terms have been excluded from equations 3 and 4 because productivity is assumed to be unaffected by changes in foreign prices. On similar grounds, an excess-demand variable has been excluded from equation 4.

[2] See, for example, Cross and Laidler (1976).

[3] The small monetary model of the Bank of England [see Coghlan (1979)] does, however, contain a price equation which in the long run relates the rate of price increase to the rate of growth of the money stock (£M3) within the context of a simultaneous model. It is intended to analyse the simulation properties of this model in a future discussion paper.

[4] These arguments relate also to services.

earnings and hence back onto domestic prices. Within the framework of this simplified model, a similar analysis would hold in the case of an appreciation, though of course this would work to reduce prices and wages.

6 Whether or not the initial exchange rate change causes proportional changes in prices and wages in the long run can only be discovered by empirical investigation. Nevertheless, derivation of the reduced-form equations of the model reveals the limiting conditions under which such proportional changes would occur. The reduced-form equations are:

$$PX = 1/A[\alpha\gamma(1-\delta)+\beta(1-\gamma)]PF \quad (5)$$

$$PM = 1/A[\beta(1-\gamma\delta)]PF \quad (6)$$

$$PD = 1/A[\beta(1-\gamma)]PF \quad (7)$$

$$W = 1/A[\beta\delta(1-\gamma)]PF \quad (8)$$

where

$$A = 1-\gamma\delta-(1-\gamma)(1-\beta).$$

Certain of the derived elasticities are of particular interest. These include:

(i) Domestic prices: $\frac{\partial PD}{\partial PF}\cdot\frac{PF}{PD} = \frac{\beta(1-\gamma)}{A}$

(ii) Nominal earnings: $\frac{\partial W}{\partial PF}\cdot\frac{PF}{W} = \frac{\beta\delta(1-\gamma)}{A}$

(iii) The terms of trade: $\frac{\partial PX}{\partial PF}\cdot\frac{PF}{PX} - \frac{\partial PM}{\partial PF}\cdot\frac{PF}{PM} = \frac{\gamma(\alpha-\beta)(1-\delta)}{A}$

(iv) Real earnings: $\frac{\partial W}{\partial PF}\cdot\frac{PF}{W} - \frac{\partial PD}{\partial PF}\cdot\frac{PF}{PD} = \frac{\beta(1-\gamma)(\delta-1)}{A}.$

7 The conditions under which a change in either world prices or the exchange rate brings about an equivalent change in domestic prices and nominal earnings, or under which the terms of trade and real earnings are left unchanged, are specified in Table A. However, even when none of the extreme conditions depicted in Table A holds, the offsetting effects to an exchange rate change may still be substantial because of the considerable interdependence of the system. To anticipate the results from subsequent sections of the paper, a number of studies have

Table A

Conditions under which domestic prices and nominal earnings change proportionately with, and the terms of trade and real earnings are unaffected by, the exchange rate

	Domestic prices change proportionately	Nominal earnings change proportionately	Terms of trade unchanged[a]	Real earnings unchanged
Export price-taker ($\alpha = 1$)			✓[b]	
Import price-taker ($\beta = 1$)				
Domestic prices wholly determined by foreign prices ($\gamma = 0$)	✓[c]		✓[c]	
Earnings respond fully to a change in domestic prices ($\delta = 1$)	✓[d]	✓[d]	✓[d]	✓[d]

[a] The terms of trade are also unchanged if $\alpha=\beta$.

[b] Providing $\beta = 1$, $\gamma\delta\neq 1$.

[c] Providing $\beta > 0$.

[d] Providing $\gamma < 1$, $\beta>0$.

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concluded that α (the weight of foreign prices in the determination of export prices) is about one half, β (the weight of foreign prices in the determination of import prices) is either equal to or not significantly different from unity, and γ (the weight of domestic costs in the determination of wholesale prices) is approximately two thirds. The extent to which earnings respond to a change in prices (δ) is more controversial. Even if the latter effect is negligible, under these conditions the terms of trade will only change ultimately by one third of the amount of a given exchange rate change. If earnings change by one half of any increase in prices, the magnitude of the terms of trade change is reduced to one quarter; and if earnings respond fully to any change in prices, there is no change at all in the terms of trade. Clearly both the magnitudes of the various coefficients and the lags before the long-run coefficients are reached are critical to assessing the impact of an exchange rate change. A more detailed discussion of the individual equations is necessary.

The determination of import and export prices

8 The effects of exchange rate changes on the domestic price level operate initially through changes in import and export prices.[1] This section examines how various studies have explained import and export prices (Table B lists the various models studied). Tables D and E, on pages 40 and 42, provide summaries of the import and export price equations, respectively. The studies, except where noted, all cover approximately the same period, from the early 1960s to about 1977. The discussion is confined largely to the manufacturing sector. It is generally assumed that the United Kingdom is a price-taker in agricultural[2] and raw materials markets on the import side and hence the foreign price coefficients are unity in the import price equations for these goods. Within any model, the relative weights of the foreign and domestic price variables in the equations for the prices of non-manufactured exports (excluding fuels) tend to be similar to the respective weights in the equations for manufactured export prices.

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[1] Proponents of a rigid Cassel-type purchasing power parity approach might argue that any attempt to trace through the effects of an exogenous exchange rate change is meaningless, since causality runs unidirectionally from domestic prices to the exchange rate as the exchange rate simply serves to equalise domestic price levels. In terms of the model of Section 2 this approach implies that $\alpha = 0$ and $\gamma = 1$. Monetarists might argue that exchange rate changes merely reflect different rates of growth of money supplies, and they too would not be interested in tracing through the effects of an exogenous exchange rate change. Some may argue that only import prices and not export prices affect the domestic price level, but the Scandinavian model suggests that export prices too have direct influence on the domestic price level.

[2] The relevant exchange rate for agricultural products covered by the Common Agricultural Policy of the European Economic Community is the green pound; this has not always moved in line with the spot exchange rate.

Table B

Models examined in this study

Model	Source of Model
Bank of England model of the UK economy	Bank of England (1979)
CEPG model of the UK	Cambridge Economic Policy Group [see Fetherston and Coutts (1979)]
Cambridge Growth Project model	Cambridge Growth Project [see Barker et al. (1979)]
HM Treasury macroeconomic model	HM Treasury (1979)
LBS quarterly econometric model of the United Kingdom economy	London Business School (1979)
Listing of the interim NIESR model IV	National Institute of Economic and Social Research (1979)
OECD model of World Trade	Organisation for Economic Co-operation and Development (1978)
IMF World Trade model	International Monetary Fund [see Deppler and Ripley (1978)]

Import prices

9 Many studies assume that import prices adjust immediately after an exchange rate change to maintain their former foreign currency value.[1] In the IMF World Trade model the relationship is estimated, but the coefficient (β) on foreign prices is not significantly different from unity. However, the Treasury and Bank models give only 60% and 75% weight respectively to foreign prices in the determination of prices of imported finished manufactures, on the grounds that some importers are price-takers in UK markets.[2] Lags are in all cases very short, in general no longer than one quarter.

[1] Modellers often do not state explicitly whether particular coefficients have been estimated or imposed. If coefficients are imposed they will invariably satisfy the homogeneity constraint. Thus if the coefficients on foreign and domestic prices and/or costs sum exactly to unity, this suggests that the restriction may have been imposed.

[2] An early study by Llewellyn (1974) found that the weight of domestic prices was about 0.4 in an equation determining the deflator of imports of goods and services over the period 1955-72. This result has not been confirmed by later studies. It is possible that the domestic price weight has fallen over time, reflecting the diminishing importance of the United Kingdom in world markets.

Export prices: the relative importance of foreign and domestic prices and costs

10 Most studies have tried to explain export prices on the basis of foreign prices, of domestic prices and/or costs, and some additional explanatory variables. The closer is the coefficient (α) on the foreign price variable in the export price equation to the corresponding coefficient (β) in the import price equation the smaller the change in the terms of trade after an exchange rate change. Moreover, if export prices have a direct influence on wholesale prices,[1] a high foreign cost/price coefficient implies a significant feed-through on to domestic prices.

11 The relevant foreign prices are those of substitutes for UK exports; the smaller the proportion of the foreign market that is supplied from the United Kingdom, and the more homogeneous the products in that market, the more will UK exporters be acting as price-takers, and the greater the influence of foreign prices on export prices. Domestic prices may influence export prices via two possible routes. First, they may represent the opportunity cost of selling in the export market, on the assumption that anything sold in the export market could instead be sold on the domestic market, or secondly, domestic prices could act as a proxy for the costs of production.[2] Costs of production can be represented by a labour cost index, sometimes used in conjunction with a domestic raw materials price index; see, for example, the IMF World Trade model [Deppler and Ripley (1978)].

12 Most studies indicate that the relative influence of foreign and domestic prices and costs in the determination of UK manufactured

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[1] This is suggested, for instance, in the Scandinavian model, which was originally developed for small, open economies. There is a fixed price for tradeables, which no individual country can influence. Thus an exchange rate change is assumed to lead to equiproportional change in the (local currency) prices of tradeable goods. Wages and profitability are equalised between the tradeable and non-tradeable sectors and this will cause price changes in the non-tradeable sector to follow those in the tradeable sector.

[2] The Cambridge Growth Project model uses this latter justification for including domestic prices in its export price equation. See Barker (1976).

export prices is about 50:50.[1] The London Business School (LBS) model gives considerably more weight to foreign prices, the elasticity of export prices with respect to foreign prices being unity in the long run. This divergence reflects the influence of the Scandinavian model of inflation on the LBS model. It is justified empirically, however, by estimating an equation of the functional form favoured by Davidson et al. (1978) in which the foreign price elasticity is constrained to be unity. A study by Ormerod (1979) suggests that this restriction is not supported by the data and in general confirms the 50:50 result found by the majority of the studies reported in Table E on page 42.[2] In general, the export price equations include relatively short lags, typically less than one year.

Disaggregated export and import prices

13 The Cambridge Growth Project (CGP) model, by far the most disaggregated of the models under discussion, suggests that the relative responsiveness of export prices to foreign and domestic influences varies considerably between industries. The aggregate result of approximately 35:65 influence of foreign and domestic variables on export prices includes, for instance, a ratio of 92:8 for motor vehicles. This last result is especially noteworthy. Barker (1976, p.137) suggests that it reflects the extent to which the home market is separated from the foreign market by product differentiation and the UK import tariff. Certainly, there is some evidence for price discrimination between countries by motor vehicle producers.[3] The

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[1] It is interesting to consider how total reliance on foreign prices in the determination of import prices is consistent with about 50% reliance on domestic prices in the determination of export prices. Such a specification suggests supply constraints on UK exporters, but these are inconsistent with the (demand-determined) export volume equations adopted in most of the models.

[2] Incomplete immediate adjustment was also found in studies of other countries. Kreinin (1977), in a recent study of the effect of exchange rate changes in eight countries since 1971, found that exporters typically offset only up to 40% of a devaluaton by raising the domestic currency price of exports.

[3] For instance, The Economist (1977) showed that the price of a Ford Fiesta in Europe ranged from £1,655 in Belgium to £4,065 in Finland. Only part of this difference can be explained by differential tax rates and transport costs.

actual price of a given model in a particular country will depend upon 'what the local market will bear' in that particular country, and need bear little relationship to the manufacturer's domestic price or cost variables.

14 The CGP model results indicate first, that apparent uniformity in aggregate data may conceal quite diverse patterns at a micro level, and second, that a higher weight on foreign price variables does not necessarily imply a more competitive world market.[1] Generally, international trade models are based on an assumption of imperfect competition between firms and countries. Thus with greater integration of world trade the market may tend towards perfect competition and the weight on foreign price variables will increase. Alternatively, international markets may become increasingly dominated by multinational corporations, which are able to practise price discrimination between countries. However, if foreign markets are separated from the UK market for export pricing purposes, then the United Kingdom will be separated from foreign markets for import pricing purposes. A high foreign price weight in the export price equation which is attributable to price discrimination implies in these circumstances a high weight on the domestic price variables in the import price equation. The CGP model, however, gives less than 20% weight to domestic prices in the import price equation.

Capacity utilisation

15 Several of the studies reported in Table E include in export price equations variables representing capacity utilisation. It is argued that firms operating at full capacity will be unable to obtain the benefits of increased sales if prices are lowered in foreign currency terms after a devaluation, and will therefore prefer to maintain foreign currency prices and take the benefits of devaluation as increased profits. This would imply a foreign currency weight of

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[1] Another result which does not accord with those of the conventional models emerges from the study of export pricing by Artus (1974). By introducing expectations, his model enables the external effect on export price changes to result from changes in domestic prices and costs. Since these domestic variables are assumed to adjust completely after an exchange rate change, no additional explanatory power can be derived from foreign price variables. Thus in the long run export prices are wholly determined by domestic variables although they return to their original foreign currency value.

unity under these circumstances. In the case of an appreciation, however, the domestic price weight would be unity because firms would not wish to lower prices. The importance of capacity utilisation has been examined especially in surveys of firms and studies using data from surveys. Holmes (1978), Hague et al. (1974), and Turner (1976) all found that capacity utilisation had an important effect on export pricing; whilst Cooper et al. (1970), and (less clearly) the Confederation of British Industry (1978) found the opposite.[1] Barker (1976, p.137) concluded that capacity utilisation was generally unimportant, and had an effect only on the less important export commodities. The contradictory findings seem hard to reconcile. One reason may be that the studies were conducted at different periods: Holmes, for instance, studied the 1972-73 period, whilst the CBI survey was conducted in 1978.

The speed of export price adjustments to exchange rate changes

16 It has been frequently suggested that the responses of export prices to an exchange rate change have recently become more pronounced. This could be reflected in two ways: either the lags in the export price equation become shorter, or the coefficient on foreign prices becomes larger. Since the lags are in any case relatively short, it is more likely that the second effect will be found.

17 In the event, only limited empirical evidence is available. Of the studies considered in this paper, only the OECD (1978), Batchelor (1977) and Ormerod (1979) have performed split-period tests. With respect to the OECD study, Table E shows that for the United Kingdom the coefficients for the 1970s were little different from the coefficients for the period as a whole. This cannot necessarily be taken as a refutation of the shorter-lags thesis. The OECD estimates for the influence of foreign prices are in any case higher than in most other studies; more importantly, the speeding-up may well have occurred only more recently, and equations run since 1970 may not pick up this effect. Batchelor concluded that the exchange rate system was important, with flexibility making exporters more aware of external factors, but found more evidence for change after the 1967 devaluation than since

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[1] Cooper et al. study export performance rather than specifically pricing, but the argument is similar.

floating. Ormerod, however, concluded that, if anything, the relative importance of domestic prices had increased over time. It may be very difficult to construct any econometric tests to examine a phenomenon that is thought to have occurred so recently.[1]

Asymmetry in response to exchange rate changes

18 Another area of interest is the possibility of asymmetry of price responses to exchange rate changes. There can be absolute and relative asymmetry. Absolute asymmetry implies that prices are totally inflexible downwards so that if a currency appreciates there will be no fall in the domestic currency prices of imports and exports but rather an increase in their foreign currency prices. Relative asymmetry implies that prices are less flexible downwards than upwards (although they need not be rigid downwards). Thus the response of domestic prices to appreciation would be slower and/or less complete than the response to depreciation. Export and import price equations for countries with appreciating currencies would, ceteris paribus, give a higher weight to domestic price variables.

19 West German experience is of relevance here, and the results of some some econometric work are shown in Table F on page 44. The IMF World Trade model gives a weight of over 50% to domestic variables in the export price equation; this might be explained on the grounds that Western Germany is a relatively large, but not particularly open, economy. However, the OECD split-period analysis shows that the heavy weight on domestic prices is a feature only of the 1970s, i.e. the period when the deutschemark has appreciated most. As this result conflicts with what might be expected from the increasing openness of the economy, it appears to be consistent with the asymmetry hypothesis. Further evidence comes from the import price equation of the IMF World Trade model where import prices are explained only in terms of foreign prices. The coefficient on foreign prices is far smaller (0.56) than the expected coefficient of unity that underlies this specification

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[1] One possible approach would be to introduce variable parameters into the export price equation (with the foreign and domestic price coefficients a function of time) to see if the foreign price component has increased over time. This project is currently under way in the Bank, but no results are yet available.

and which would have refuted the asymmetry hypothesis. Some counter-evidence has been provided by Pigott et al. (1975). The absolute asymmetry hypothesis carries the implication that reductions in the domestic currency price of exports and imports should be rather infrequent. However, for six countries taken as a whole[1] import prices fell in twenty-seven out of the seventy-six quarters between 1957 and 1975 and export prices fell in twenty-two of these quarters.[2]

Summary

20 Import prices are generally considered to adjust completely and almost immediately to any exchange rate change although for prices of imports of finished manufactures two models give a weight of at least one quarter to domestic prices. Export prices of manufactures are determined approximately 50:50 by foreign prices and domestic prices or costs. Disaggregated data on export prices suggest that these apparently uniform results conceal widely divergent responses at a micro level. There is no conclusive evidence on the importance of capacity utilisation on the pricing mechanism, or whether there has been a recent speeding-up in price responses, or whether there is asymmetry in price responses between appreciations and depreciations.

[1] The countries were the United States, the United Kingdom, Canada, Japan, Western Germany and France. The export and import prices considered include both non-manufactured and manufactured goods.

[2] A further asymmetry may arise in the response of wholesale prices to changes in import prices. This subject is examined in Section 4.

The determination of domestic prices

21 The transmission of import cost changes into final prices follows two main channels. One is direct, where imports enter consumption without passing through domestic production. The lags with which changes in the prices of directly consumed imports affect domestic prices may be expected to be fairly short, corresponding to the length of time during which the goods are held in stock. The other channel of influence is through domestic production. Part of this second influence is also direct (the import content of production) but in addition the prices of competing products may also affect domestic prices. The majority of studies have concentrated on the determination of wholesale prices; these are reviewed first, but the relationship between wholesale and consumer prices is also noted.

22 Most studies relate domestic prices to domestic labour costs and import prices [e.g. Neild (1963), Lipsey and Parkin (1970), Coutts et al. (1978)]. Such a specification may be taken to reflect a constant percentage mark-up pricing policy. Price equations of similar form, however, may also be derived from 'neoclassical' profit maximising behaviour, as shown by Nordhaus (1972). If it is assumed in the mark-up framework that the import content of output is constant, that unmeasured costs are a constant function of measured costs and that firms aim for a constant percentage mark-up, then it is possible to derive equation 3 of the model specified in paragraph 3. Furthermore, this derivation implies that three theoretical restrictions should apply to the coefficients: the constant should be zero, the coefficients on the change in earnings and import prices should reflect the relative weight of earnings and imports in total costs[1] and the coefficient on the change

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[1] They should equal the shares of earnings and import prices in the final price times a constant factor which equals $\frac{1+A}{1-B}$ where A is the ratio of unmeasured to measured costs and B is the percentage mark-up.

in labour productivity should be equal, but opposite in sign, to the coefficient on the change in earnings.[1]

23 Some modifications to this equation reflect the fact that the ratio of unmeasured to measured costs may not be constant. There are two major reasons for this. First, the average tax rate may change over time, as a result, for example, of changes in corporate tax rates or investment allowances so that the average tax rate should be included in the equation. Secondly, fixed costs per unit of output will vary with capacity utilisation; as a result some studies include capacity utilisation as an additional explanatory variable.

24 Many studies assume that firms set prices with reference to 'normal' or 'standard' as opposed to actual costs. For example, Coutts et al, (1978) state: "Our hypothesis is that firms will measure costs by reference to a 'normal' level of capacity utilization which they will not vary cyclically and that they will add a non-cyclical profit margin." As a result, several of the explanatory variables enter with lags in most studies. The interpretation of these lags may not be unambiguous, however. They may reflect historic cost pricing and lags in the production process or institutional rigidities in translating cost changes into price changes. They may also exist if price revisions entailed significant costs. Alternatively, or additionally, they could reflect the fact that firms may only react to cost changes which they regard as permanent, normal cost expectations being formed with reference to actual cost developments. It is also possible that lags on productivity changes may be longer than on wage or import price changes because firms may be slow to perceive the former. In general, most estimated lags are fairly short, typically implying adjustment is completed within one year.

The relative influence of domestic costs and import prices

25 The relative weight attributed to the labour costs (γ) and import price ($1-\gamma$) coefficients is controversial. It can be argued that the mark-up approach referred to above implies that the

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[1] As noted earlier, labour productivity is assumed constant in the model specified in paragraph 3 and hence does not appear in the equations.

influence of import costs is limited to the import content of domestic manufacturing output and hence that the import price weight should be estimated from input/output data.[1] Inter alia, this implies that no weight is given to the influence of competing import prices, a conclusion supported by the regression analysis of the Coutts et al. (1978) study. But in general, where the relative weights have been estimated by regression methods the import price weight is greater than that indicated by input/output considerations. The LBS model has an estimated weight of 0.69 for the 'foreign price' variable which is, in this case, an index of world wholesale prices. This high foreign price weight moderates the divergence between domestic and foreign manufacturing prices following an exchange rate/foreign price change and implies a move towards the Scandinavian theory of inflation (see paragraph 10). The influence of foreign prices is, therefore, considerably greater in the short run in the LBS model than in, for example, the Bank or Treasury models (see Table G on page 46). None of the models attempts to allow for differing influences from competing foreign prices under fixed and floating exchange rate regimes.

26 As noted above, the higher coefficient on foreign prices in the wholesale price equation (higher, that is, than the input/output coefficient) may be interpreted as the effect of foreign competition on domestic prices. Profit margins would tend to increase (decrease) when foreign prices (in sterling terms) were rising faster (slower) than unit labour costs. A change in the exchange rate would, in these circumstances, exert a double effect on prices - not only through costs, but also through profit margins. The import cost

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[1] The use of the input/output data in this context introduces several problems. First, the data reflect the relationship between prices and lagged costs and should be adjusted accordingly; however, input/output data give no information on the lags involved. Secondly, the adoption of fixed weights implies that import propensities are constant which may well not be the case, either in the past or in the forecast period. This assumption is noted in paragraph 22. Thirdly, it is not possible to test for non-linearities in the domestic price/import price relationship. Fourthly, the import content of production should be scaled-up by the constant factor mentioned in the footnote on page 18. [See Lipsey and Parkin (1970).] Estimation of the weights by ordinary least squares regression techniques involves other problems, including simultaneous equations bias and multicollinearity.

reducing effect of an appreciation of sterling would be reinforced to some degree by downward pressure on profit margins.

27 The constant mark-up approach has been criticised on the grounds that it ignores the influence of demand on profit margins. This criticism is not wholly valid, however. If, for example, trend productivity is used, it implies that actual profit margins move pro-cyclically.[1] Also, in equations using actual productivity, the absolute size of the coefficient may be less than that on wages, which could reflect the impact of demand on prices because productivity moves pro-cyclically. Furthermore, demand may still have a strong indirect influence on domestic prices.[2] The Coutts et al.(1978) study contains extensive tests of the normal price hypothesis - that selling prices relative to lagged normal unit costs are independent of demand - and concludes that such effects are negligible.

Asymmetry in the response of wholesale prices to import price changes

28 It is frequently argued that downward price rigidities cause changes in exchange rates to be asymmetrical, as between appreciation and depreciation, in their effect on domestic prices. One possible source of this asymmetry lies in the response of export and import prices to foreign price changes.[3] Another source is the response of domestic prices to changes in import prices. The argument is that import prices adjust almost fully to their original foreign currency equivalent after an exchange rate change: thus, they rise after a depreciation and fall after an appreciation. Wholesale prices are inflexible downwards, and therefore follow an increase, but not a fall, in import prices.[4] The asymmetry argument may also hold if prices are relatively unresponsive to unexpected changes, or to changes which are viewed as transitory, and if producers discriminate on these grounds between appreciation and depreciation.

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[1] If firms attempted to achieve a target profit rate, the opposite might occur.

[2] For example, by influencing import costs via the exchange rate or, even more indirectly, by affecting wages.

[3] See paragraphs 18 and 19.

[4] Given the general upward trend of prices, this downward asymmetry may not be encountered. An appreciation may not indicate that a reduction in prices is warranted, but may lead to a slower rate of increase.

29 Goldstein (1977) has carried out the most extensive investigation of this hypothesis. He presents six alternative models of inflation, to overcome the accusation that his results are dependent solely on choice of model. In each case, a dummy variable is introduced which takes the value of unity when there is a positive import price change and of zero when the change is negative.[1] Annual data are examined for five countries (the United Kingdom, the United States, Western Germany, Italy and Japan) for 1958-73 and are pooled to increase the sample size. The pooled results provide no support for the asymmetry hypothesis.[2] The coefficient on the dummy variable is in all cases not significantly different from zero. In the tests on individual countries, some limited support for the hypothesis was found with the coefficient on the dummy significant for some of the countries in some of the models. However, in no case was the coefficient significant for the United Kingdom or Western Germany. Overall, Goldstein's work must therefore cast severe doubt on this aspect of the asymmetry hypothesis. Further refutation of this hypothesis is provided by the tracking record of the Bank model's wholesale price equation which has explained the rise in these prices since 1976 relatively well; if the weight attributable to domestic prices had increased, as the asymmetry hypothesis indicates, the equation would have underpredicted in the recent past.

Wholesale prices and consumer prices

30 The translation of changes in wholesale prices into consumer prices has received much less attention than has the wholesale price equation. Many empirical studies have not explicitly acknowledged the link, preferring to estimate a reduced form equation, with consumer prices directly dependent upon import and domestic costs [for example, Lipsey and Parkin (1970)]. Work on the Bank model, which employs the wholesale price index as a key variable within the prices sector, suggests that most of the impact on consumer prices of the

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[1] This is equivalent to dividing the import price-change variables into positive and negative changes, entering these as separate regressors in the price-change equation, and testing for the equality of the coefficients.

[2] This result holds both for the complete estimation period 1958-73 and also for the sub-period 1958-70. It also holds when disaggregated price data for manufactures are used.

change in wholesale prices occurs in the same quarter. It follows from this that the lags on import prices and domestic costs are similar in the consumer price and wholesale price equations. In the Bank's equation for the deflator for non-durable consumption, wholesale prices carry a weight of two thirds, with most of the rest accounted for by domestic unit labour costs (reflecting the services component of consumers' expenditure). In the corresponding equation for the deflator for durable consumption the weight of wholesale prices is four fifths while direct import prices carry a weight of one tenth.

The determination of earnings

31 The response of earnings[1] to an exchange rate change depends upon the direct and indirect reaction of the determinants of earnings to the exchange rate adjustment and the elasticity of earnings with respect to each of these determinants. Of particular importance, especially initially, is the response of earnings to changes in prices. This section summarises the following aspects of this relationship:

(i) theoretical relationships;
(ii) the long-run response; and
(iii) the speed of adjustment.

Theoretical relationships

32 Economic theory suggests several explanations for the generally recognised positive relationship between the rate of change of earnings and the rate of change of prices. Neoclassical theory states that both the demand for and supply of labour are, *inter alia*, functions of the *real* wage. On the demand side, this reflects the desire of firms to minimise costs; given the state of technology and with capital and other factors of production fixed in the short term, this implies that firms will hire labour until the value of the marginal physical product of labour (MPPL) equals the nominal wage, i.e. until the MPPL equals the real wage. The supply of labour is assumed to be a function of the real wage because, given the absence of money illusion, the real wage is the true measure of the rewards from employment and the cost of leisure.

33 Thus, if the real wage is initially at its equilibrium level, a change in prices[2] will cause the supply of, and demand for, labour to diverge; this will be eliminated when money wages have changed in proportion to the movement in prices. A similar strong prediction of a unitary partial elasticity of wages with respect to

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[1] In this section, except where explicit mention is made of the difference between wages (that is, basic rates) and earnings (that is, total compensation), the two terms are used interchangeably.

[2] It should be noted that the price series used to deflate nominal wages need not be the same on both sides of the labour market: see, for example, Parkin, *et al.*(1976).

prices may be derived from certain variants of the 'target-real-wage hypothesis'.[1] The basic theory is that employees strive to attain a 'target-real-wage' and that the change in nominal wages is a function of the difference between the 'target-real-wage' in the current period and the actual real wage in the previous period. The 'target-real-wage' is unobservable but it is often assumed to increase at a constant rate.

34 Many early studies included lagged price terms to reflect the 'catching-up' of earnings on previous price increases [for example, Dicks-Mireaux (1961)]. Later studies have argued that future rather than past prices are theoretically relevant because the real value of the nominal wage contract over the contract period is determined by future prices. Several hypotheses have been put forward explaining the formation of price expectations, including the naive expectations model (expected inflation equals actual inflation in the preceding period) and the adaptive expectations model (expected inflation equals expected inflation in the previous period plus a proportion of the error in forecasting the rise in prices in the previous period).

35 It is unlikely that expectations about future rates of inflation are formed by a wholly adaptive scheme - which implies that the exchange rate can affect wages only after it has affected prices. Because the price implications of exchange rate changes are widely realised, such changes may be expected to feed directly into price expectations[2] and from there into wages without having altered prices first. Thus the presence of rational expectations may be expected to cut short the transmission process considerably. There is doubt as to whether or not wages may respond differently to exchange rate appreciations and depreciations. Economic theory provides no support for the existence of absolute asymmetry. It may still be true, however, that wages may respond more slowly to an appreciation and the attendant slowing of inflation than to a quickening of inflation consequent upon depreciation. This would have important implications and would suggest that, whilst the gain

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[1] See, for example, Sargan (1964) and Henry, et al.(1976).

[2] Work on the Carlson-Parkin expectations series by Carlson and Parkin (1975) and by Smith (1978b) confirms this, suggesting that the 1967 devaluation raised the expected inflation rate by about 6%. Similar results follow from Bank research.

in cost competitiveness following depreciation might be short-lived, the deterioration in competitiveness resulting from appreciation could be painfully long. Unfortunately, empirical evidence is lacking in this area and no firm conclusions may be drawn.

The long-run response

36 Typically, in early studies, the value of the coefficient δ in equation 4 was found to be around one half (see Table H on page 48) and significantly less than unity, implying that exchange rate changes would result in a change in cost competitiveness. The estimated coefficient on prices was fairly sensitive to the specification of the equation. In comments on the difference between his estimate of 0.46 and the much higher estimate (over 0.85) of Klein and Ball (1959), Dicks-Mireaux (1961) noted that '...the estimate is a fairly unstable one ... and once again illustrates the difficulty of obtaining precise estimates of the internal links in the wage/price complex...'. Similar instability was found by Burrows and Hitiris (1972) and by Sumner (1972).

37 A number of reasons may be advanced to explain why the estimated coefficient on price changes was found to be significantly less than unity. Sumner (1972) reported a non-linear response - price increases below 2% did not appear to affect the rate of change of wage rates - but he was unable to say whether this reflected adjustment costs or a possible trade-off between product quality and price. Saunders and Nobay (1972) showed that the derived estimate of the elasticity of earnings with respect to prices depended upon the assumed form of the expectations-generating function.

38 As the use of arbitrary weighting schemes to generate an expected inflation rate from past inflation rates enables almost any value of δ to be estimated, Carlson and Parkin (1975) constructed expected inflation rate series from qualitative survey responses. They found that the hypothesis that the expected rate of inflation depended upon previous actual inflation and exchange rate changes plausibly characterised expectations formation. Some other studies[1] have used one or more of the Carlson-Parkin series in wage equations and have concluded that δ is about unity, implying that wages respond

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[1] See, for example, Parkin, et al.(1976) and Gray, et al.(1975).

fully to changes in prices. The same conclusion emerged from studies which were estimated using data extending into the mid-1970s and which continued to employ expectations-generating functions.[1] Finally, as noted in paragraph 33, in those studies which adopted a 'target-real-wage' function, the long-run elasticity of wages with respect to prices is unity by assumption.

39 There have been few empirical studies utilising rational expectations models.[2] Evidence from McCallum (1975), using consistent estimation methods, does, however, suggest that the hypothesis of wholly-rational expectations (dependent upon - amongst other factors - changes in import prices, money, unit labour costs and the lagged level of prices) may provide a better fit to the data than that of partly-rational expectations wholly dependent upon previous price changes. McCallum's study also provides support for the hypothesis that the elasticity of earnings with respect to price expectations is close to unity. His preferred equations, which include a lagged real wage term (although with a different rationale to that used by those supporting the 'target-real-wage' hypothesis), imply almost complete adjustment to changes in prices after one quarter.

40 Despite the upredicatability of the wage/price linkages, all the models examined incorporate some sort of relationship linking wage changes to price changes, although for forecasting purposes these equations are often overridden. Among these models, the CEPG - employing a 'target-real-wage' equation - the CGP, the Bank and the Treasury assume eventual complete compensation for changes in prices (consumer prices in the CGP, the CEPG and Bank models, retail prices in the Treasury model); in the LBS model the coefficient on wholesale selling prices in the equation for weekly earnings in manufacturing (which determine total average earnings) is assumed to be unity. In the NIESR model the elasticity of wage rates with respect to consumer prices is 0.68, implying that exchange rate changes result in a change in real wages.

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[1] Amongst others, the following studies found that the data did not reject $\delta = 1$: Mackay and Hart (1974), Johnston and Timbrell (1973), Goldstein and Khan (1974) and Artis, et al.(1977).

[2] Recently a number of working papers have applied rational expectations theory to wage equations, for example, Ormerod and Henry (1979) and Minford and Brech (1979).

The speed of adjustment

41 There is little theoretical guidance about the lag distributions which should be expected to result from econometric work on prices. There is, however, a general presumption that lags will be found. In the early studies (which viewed wages as catching-up on earlier, rather than anticipating future, price increases) lags were interpreted to reflect the negotiation and implementation process, which included a wage round effect (hence the use of four quarter differences in estimation). In the studies explicitly including price expectations in the wage equation, lags reflect not only institutional rigidities but also the dynamics of expectations formation.

42 The lag distributions on prices implied in published studies vary substantially from study to study. In some cases, the adjustment to higher prices is implied to be complete after four quarters (with an average lag of about two quarters), though with adaptive expectations models the adjustment period is much extended. In other cases, lags are often implied to be very short. For example, within the 'target-real-wage' framework, with the estimating equations augmented by the recent rate of inflation, some recently published work, by Henry et al.(1976), and by Henry and Ormerod (1978), imply that over half the adjustment to a price change is completed after one quarter. Omission of the price inflation variable worsened the fit and implied very much slower adjustment.

43 Many studies have found that the size and significance of the coefficient on prices and/or on lagged real wages tended to increase as the sample periods were extended.[1] This supports the hypothesis that higher rates of inflation have led to increasing awareness of the implications for real wages of likely price developments, and that these have been taken into account when striking money wage bargains.

44 The degree to which the published studies differ over the timing of the response of earnings to price changes perhaps reflects the fact that the data are statistically not sufficiently well behaved to enable conclusions to be reached with any great degree of confidence.

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[1] See, for example, Goldstein (1974) and Artis et al.(1977).

Table C shows that the proportionate change in prices in the current quarter is highly correlated with preceding quarter-to-quarter changes. These problems are much exacerbated when overlapping four quarter differences are used - as in many studies. Even if the quarterly price inflation series were white noise, the correlation between successive four quarter differences would be 0.75 because successive values would have three quarterly observations in common. Because the quarterly price inflation series is not white noise, the correlation (0.97) is much higher.

Table C

Correlation between the first difference of (the log of) the deflator of consumers' expenditure in quarter t, and in quarter t_{-i}

1957 4th quarter to 1978 4th quarter

i =	1	2	3	4	5	6	7	8
	.84	.76	.68	.67	.63	.62	.55	.53

45 The speed at which earnings are estimated to adjust to price changes varies widely between the various econometric models of the United Kingdom. The most rapid adjustment is implied by the LBS model, with 75% of any change in wholesale prices affecting earnings after one quarter and 25% of any change in consumer prices affecting earnings after two quarters. The adjustment lag is longest in the NIESR model which includes a lagged dependent variable. The wage relationships in the Treasury and Bank models produce full compensation for price increases after about two years. The CEPG and CGP models (using annual data) also take up to two years for a full adjustment to price changes.

46 The literature on the influence of incomes policies on earnings in the United Kingdom is extensive. The evidence from this rather discordant literature suggests that the large number of incomes policies adopted in the United Kingdom since the war have met with varying success; incomes policy appears to have been successful in 1948-50 and in stages one to three of the most recent policy, but has probably failed to reduce the rate of earnings increase in other periods. Wages, however, have tended to rebound following the removal

of a successful policy and, even when effective, incomes policy may have been more successful in holding down basic rates than in containing the rise of earnings.

47 An exchange rate change will alter the values of variables other than prices which enter the wage equation. These variables may act to reinforce or to reduce the influence of prices on wages. One such effect may operate through the demand for labour. If the exchange rate rises/falls the demand for labour may be expected to fall/rise, perhaps resulting in a slower/faster rate of wage increase. Whilst the response of earnings to pressure of demand changes may be of great importance in determining the economy's long-run response to an exchange rate change, the existence of a stable short-run trade-off between excess demand for labour, or its frequently used proxy, unemployment, is open to doubt. This area is sufficiently large and controversial to be properly the subject of a separate paper.

Summary

48 The empirical evidence suggests that:

(i) earnings have become more responsive to price changes, with the elasticity approaching unity in recent periods;

(ii) the speed of adjustment of earnings to prices is not certain and may be variable. Some evidence suggests, however, that it may have become more rapid with the experience of higher rates of inflation. The lag between significant and highly-publicised changes in the exchange rate and earnings may be very rapid, because the price effects of the exchange rate change may be anticipated; and

(iii) incomes policies may alter the timing of the transmission of import price changes into earnings, but they do not appear to have a long-run effect.

Model simulations

49 Previous sections of this paper have discussed the individual price and wage equations. It is necessary, however, to take account of the interdependence of the cost/price system in order to assess both the long-term impact of an exchange rate change on prices and costs and also the lags involved before the final effects are realised. This section attempts this in two ways. First, a series of different coefficients and time-lags have been assigned to the relatively simple model specified in Section 2 and mechanistic simulations have been made to illustrate the process by which a once-for-all appreciation of the (effective) exchange rate may be transmitted as changes in domestic wages and prices. The results using three variants of the basic model are shown in Tables J-L (on pages 52-4) and Charts A-C (on pages 33-5). The three variants are intended to represent a slow, medium and fast adjustment process respectively. Secondly, a similar simulation has been performed on the Bank short-term model.[1] Inter alia, this incorporates other feedback effects (for example, between the exchange rate and output) which are not taken into account in the simple model.

Mechanistic simulations of the simple model

50 Before considering these simulations, it is important to recall their more obvious limitations. Perhaps most important, it will be evident that the model does not attempt a complete representation of the process: the effects of an appreciation of the exchange rate on the level of output or on later developments of the exchange rate are not taken into account. For example, both productivity and unemployment are assumed to be exogenous. (Some allowance for the real effects could perhaps be made qualitatively, since Tables J-L give some indication of the way real wages and export and import competitiveness might be expected to develop.)

51 In variant I (Table J) earnings do not fully compensate for previous price changes, so that an exchange rate appreciation would be only partially reflected in the long-run development of prices and wages.

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[1] The model is described in detail in Bank of England (1979).

The real effects are more difficult to assess. With an appreciation, an improvement in real earnings should help to sustain output; on the other hand, there would be a fairly pronounced loss of export and import competitiveness. The adverse effects on the current account of the balance of payments of the worsening of the balance of resources (export volumes less import volumes) would tend to be offset by an improvement in the terms of trade.

52 The process illustrated in this variant is a long-drawn-out one. After four to five years, the change in domestic prices is still only just over one half the initiating change in the exchange rate. It may be relevant to note that the Bank model also results in a long-drawn-out process somewhat similar to variant I (see the simulation in Table M on page 55), though unlike variant I the Bank model provides that changes in earnings should eventually compensate fully for price changes.

53 Variant II (Table K) could perhaps be regarded as the 'median' model derived from the available empirical evidence. After three years some 80%-90% of the initiating exchange rate appreciation is reflected in the development of wages and prices. The gain to real wages falls away fairly quickly after about eighteen months to two years, as does the terms of trade gain; the loss of cost competitiveness persists rather longer.

54 Variant III (Table L) assumes that, within a year, around 90% of an initial appreciation of the exchange rate would be reflected in earnings and prices. The real effects, favourable or adverse, would also be largely worked out within a year and certainly within two years. The empirical evidence suggests that a process as fast as this is towards the extreme range of probability.

55 Charts A-C compare the three variants with respect to changes in domestic prices, in earnings and real earnings, and in the terms of trade.

Bank short-term model simulation

56 Table M summarises the impact on selected price and wage variables of a 10% exchange rate appreciation using the Bank

Chart A

10 % exchange rate appreciation: effect on domestic price level

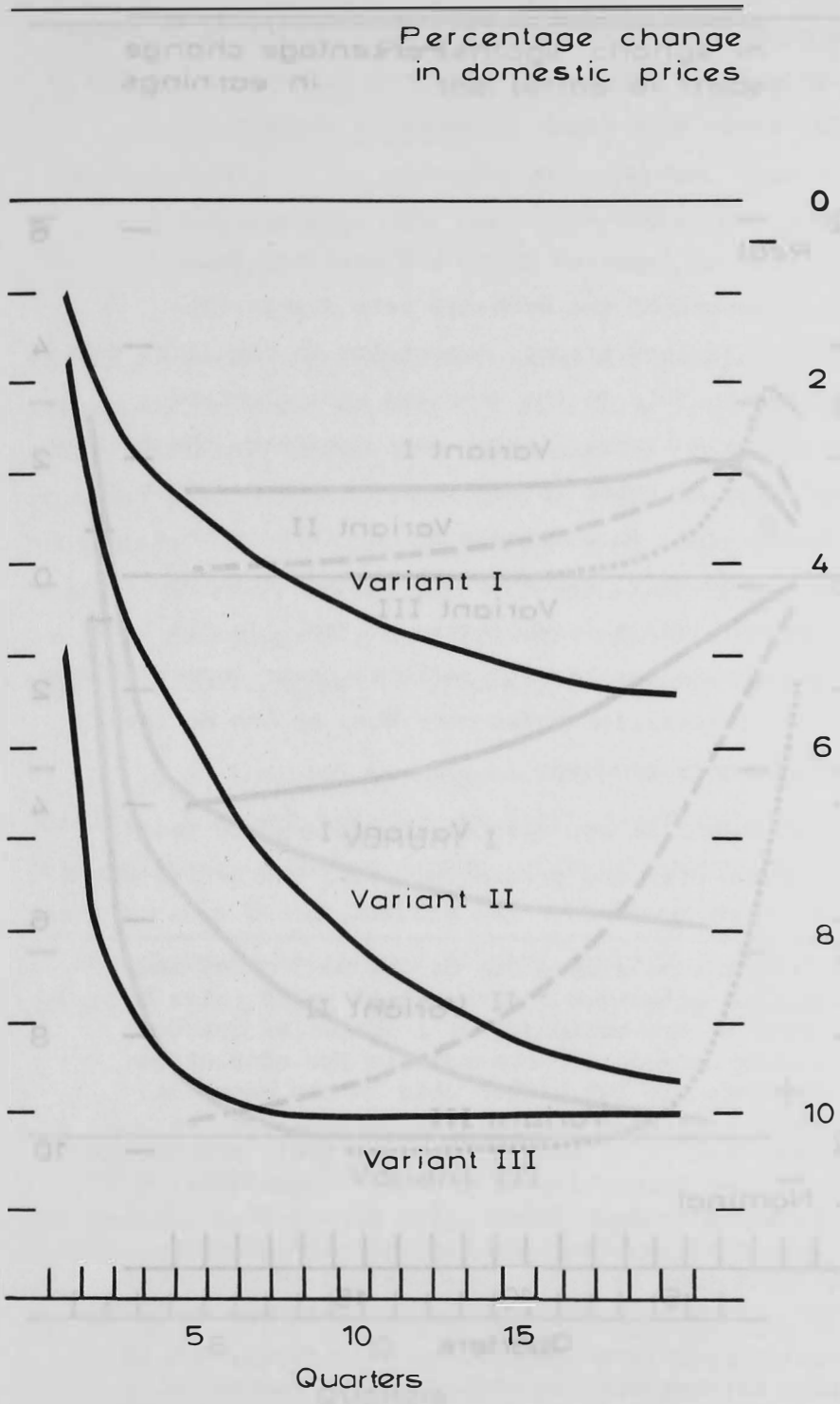


Chart B

10% exchange rate appreciation: effect on nominal and real earnings

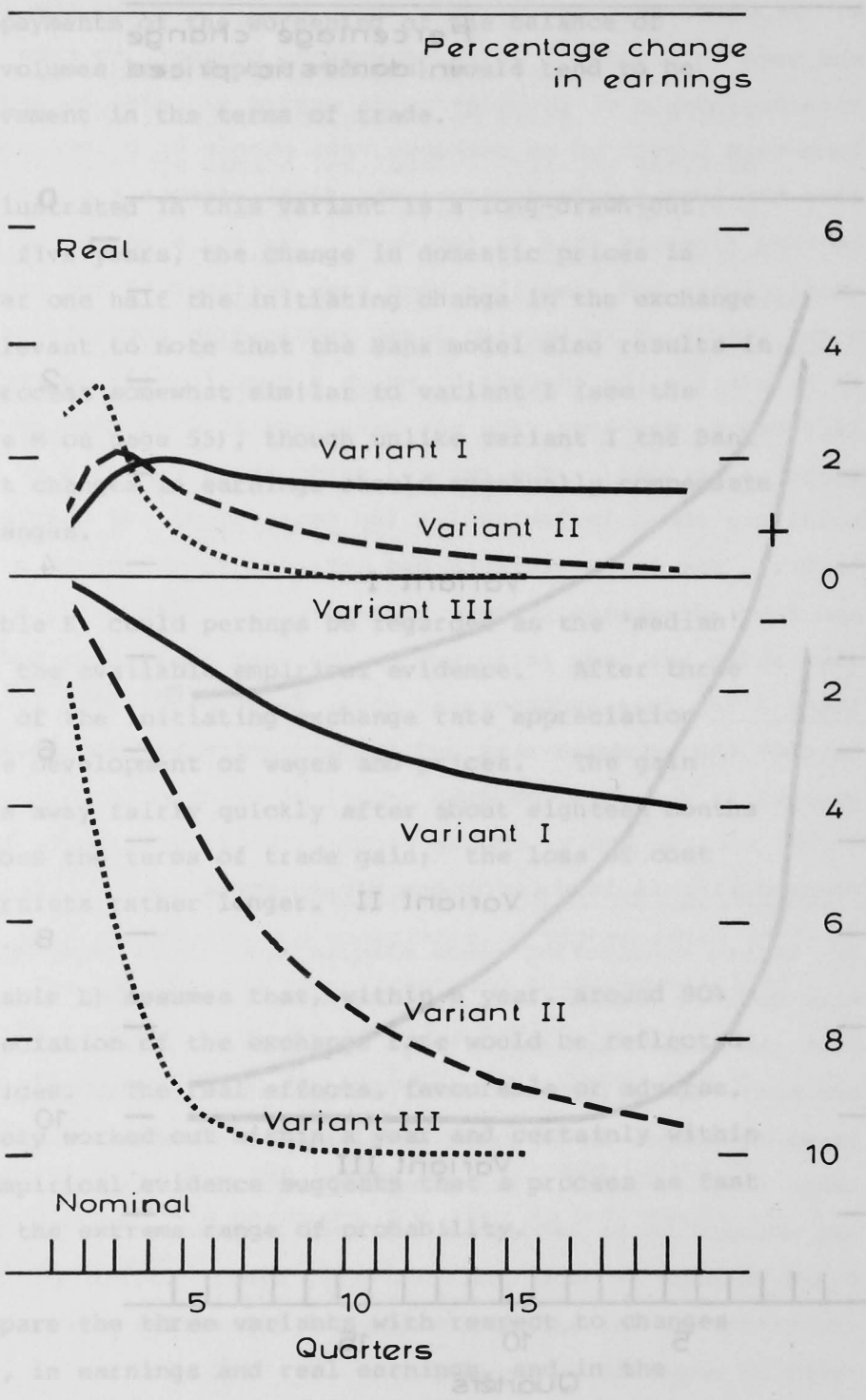
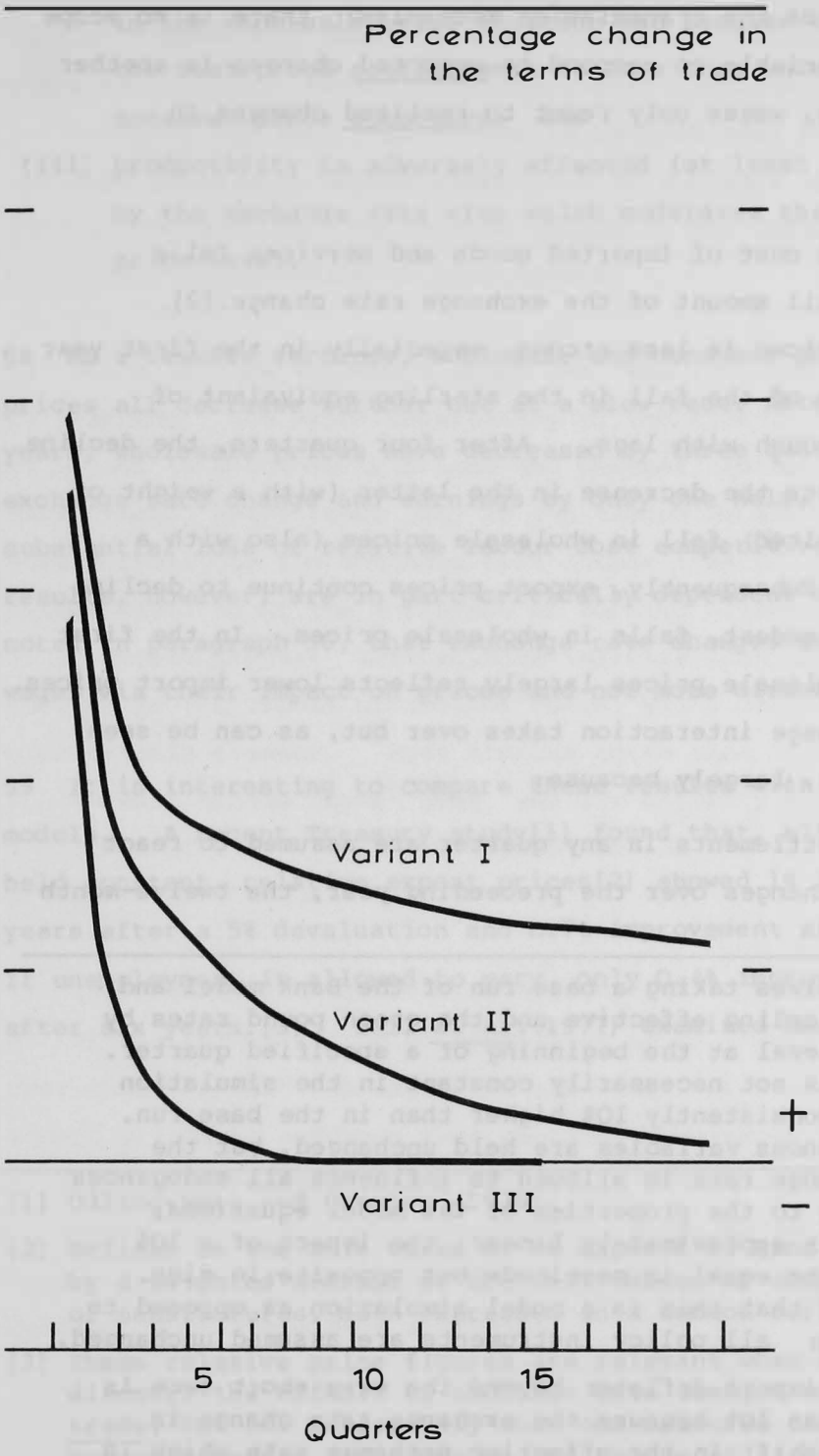


Chart C

10% exchange rate appreciation : effect on the terms of trade



short-term economic model.[1] This version of the model presents a fairly extreme picture of the response of domestic prices to exchange rate changes. Most lags in the model are longer than those suggested in most of the studies described in the paper. This is largely due to the sequential process of the transmission mechanism: there is no scope in the model for any variable to respond to expected changes in another variable: for instance, wages only react to realised changes in consumer prices.

57 As can be seen, the cost of imported goods and services falls quickly by about the full amount of the exchange rate change.[2] The impact on export prices is less strong, especially in the first year when the direct effects of the fall in the sterling equivalent of foreign prices come through with lags. After four quarters, the decline in export prices reflects the decrease in the latter (with a weight of one half) plus the (limited) fall in wholesale prices (also with a weight of one half). Subsequently, export prices continue to decline due to further, albeit modest, falls in wholesale prices. In the first year, the change in wholesale prices largely reflects lower import prices. Thereafter, the price/wage interaction takes over but, as can be seen, this is relatively weak, largely because:

(i) although wage settlements in any quarter are assumed to react fully to price changes over the preceeding year, the twelve-month

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[1] The simulation involves taking a base run of the Bank model and raising both the sterling effective and the green pound rates by 10% from the base level at the beginning of a specified quarter. The exchange rate is not necessarily constant in the simulation period, but it is consistently 10% higher than in the base run. The values of exogenous variables are held unchanged, but the change in the exchange rate is allowed to influence all endogenous variables according to the properties of the model equations. Because the model is approximately linear, the impact of a 10% depreciation would be equal in magnitude but opposite in sign. It must be stressed that this is a model simulation as opposed to a policy simulation; all policy instruments are assumed unchanged.

[2] The decline in the import deflator beyond the very short term is slightly greater than 10% because the exchange rate change is brought about by a shift in the effective exchange rate which is specified in terms of units of foreign currency per unit of sterling, whereas the relevant exchange rate term in the import price equations is specified in terms of units of sterling per US dollar; with this specification a 10% appreciation of the effective rate corresponds to a 11.1% appreciation of the sterling/dollar rate. The import deflator does not fall by 11.1% immediately because of lags and because the UVI for imports of finished goods is influenced by domestic prices.

rule is assumed to hold and hence only a proportion of settlements are initially affected;

(ii) the initial change in consumer prices is less than that of wholesale prices because the import price weight is lower than in the wholesale price equation and because the sum of the cost/price coefficients is less than unity in the consumer price equations; and

(iii) productivity is adversely affected (at least temporarily) by the exchange rate rise which moderates the fall in the price level.

58 As a result, earnings, wholesale and consumer prices and export prices all decrease further but at a slow rate. After three to four years, wholesale prices have decreased by three quarters of the exchange rate change and earnings by only one half, implying a substantial loss of relative labour cost competitiveness. These results, however, are in part critically dependent on the assumption, noted in paragraph 56, that exchange rate changes only affect wages via their impact on prices and not more directly.

59 It is interesting to compare these results with those from other models. A recent Treasury study[1] found that, with unemployment held constant, relative export prices[2] showed 1% improvement four years after a 5% devaluation and 0.7% improvement after six years. If unemployment is allowed to vary, only 0.4% improvement will remain after six years.[3] Ball et al.(1977) examined how the LBS model

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[1] Odling-Smee and Hartley (1978).

[2] Defined as the unit value of UK exports of manufactures divided by a weighted average of the unit values of competitors' exports of manufactures, both expressed in a common currency.

[3] These relative price figures are relevant when one wishes to discover the effects of exchange rate changes on the terms of trade, but not necessarily when one measures the effect on competitiveness and hence on the volume of trade. For competitiveness one has to look in addition at the effect on relative normal unit labour costs. See Enoch (1978) and Allen and Brown (1978). Odling-Smee and Hartley found that, with constant unemployment, over half the benefit of the exchange rate change on competitiveness, as measured by normalised unit labour costs, persisted even after six years.

traces the effects of exchange rate changes,[1] and found that it takes about four years to remove 75% of the price effect of the devaluation and six years to remove the entire amount. Thus, in these models, exchange rate changes are unable to alter relative prices except in the short run.

[1] This work refers to an earlier version of the LBS model than the version included in Table B. See Ball et al.(1977).

Conclusions

60 It is generally accepted that a change in foreign prices or the exchange rate will result in proportionate changes in domestic prices and costs in the long run. This is because most studies indicate that earnings eventually adjust completely to a change in prices, though the more direct influence of foreign prices in the determination of domestic prices also contributes to this result.

61 There is less agreement about the lags involved before the long run is reached. The major uncertainty is the time it takes earnings to adjust to a change in prices and whether, following an exchange rate change, wages react only to the lagged impact of domestic prices or more directly to the exchange rate change itself. There is also disagreement about the influence of foreign prices in the determination of wholesale prices; some studies indicate that this influence is limited to the import content of costs, while others suggest it is considerably greater. Most studies agree that the United Kingdom is a price-taker on the import side, and the majority indicate that the influence of domestic and foreign prices in the determination of export prices is about equal.

62 There is as yet little firm evidence to suggest that the influence of foreign prices in the determination of UK export prices has changed over time, or that the lags have shortened, or that the response of export prices to exchange rate changes is asymmetric. There is no evidence that the response of wholesale prices to import price changes is asymmetric. Although considerable problems exist in estimating the lags between price changes and the impact on earnings, there is some evidence that these have shortened.

Table D

Import prices

Model	Dependent variable[a]	Weight of variables[b]		Foreign cost/ price variables in equation
		Foreign	Domestic	
Bank	UVI of imports of finished manufactures	0.76	0.25	World prices of semi and finished manufactures
CEPG	AVI of imports of finished manufactures to business sector	1.0	0	World price of exports of manufactures
CGP	Import unit values	0.81	0.19	World prices
Treasury	UVI of imports of finished manufactures	0.60	0.40	World price for exports of goods by OECD countries
LBS	UVI of imports of manufactures	1.0	0	Price index of world manufactures
NIESR	Deflator of imports of goods excluding oil and gas	1.0	0	None
IMF World Trade	Import unit value of manufactures	1.0	0	Competitors' export prices

Note: All equations are run with quarterly data except the IMF World Trade model which is run with semi-annual data and the CEPG model which is run with annual data.

[a] Where a model predicts the price of imports of finished manufactures separately, it is almost always accompanied by an equation for the price of imports of semi-finished manufactures which are determined 100% by foreign variables (90% in the Treasury model).

[b] The weight on the foreign variable represents the coefficient β in the model specified in Section 2; the weight on the domestic variable represents the coefficient $(1-\beta)$.

Domestic cost/price variables in equation	Other variables in equation (excluding dummies)	Lags on cost/price variables	Forms of equation
Wholesale price index of manufactures	Lagged exchange rate adjustment	None	Linear in logs
None	Adjustment for import duties	One year	Linear in logs
Home unit costs	None	None	Linear in logs
Wholesale price index of manufactures (excluding food, drink and tobacco)	None	One quarter	Linear in logs
None	Lagged exchange rate adjustment	Partial adjustment	Hendry
None	None	None	No equation
None	None	One half-year	Linear in logs

Table E

Export prices

Model	Dependent variable[a]	Total weight of variables[a]		Foreign cost/ price variables in equation
		Foreign	Domestic	
Bank	UVI for exports of manufactued goods	0.53	0.53	Competitors' export prices
CEPG	Deflator for exports of goods and services (excluding fuel)	0.50	0.50	World price of exports of manufactures
CGP	Export UVIs	0.35	0.65	World prices
Treasury	UVI for exports of manufactured goods	0.52	0.48	Competitors' exports prices
LBS	UVI for exports of manufactured goods	1.0	0	Competitors' world prices of manufactures
NIESR	Deflator for manufacturing exports	0.48	0.49	Competitors' world prices of manufactures
OECD				
1963-77	Export UVIs	0.69	0.33	Competitors' export average values
1971-77	Export UVIs	0.69	0.31	
IMF World Trade	UVI for exports of manufactured goods	0.51	0.49	Competitors' export prices

Note: All equations are run over quarterly data except the IMF World Trade model which is run over semi-annual data and the CEPG model which is run over annual data.

[a] The weight on the foreign variable represents the coefficient α in the model of Section 2; the weight on the domestic variable represents the coefficient $(1-\alpha)$.

Domestic cost/ price variables in equation	Other variables in equation (excluding dummies)	Lags	Forms of equation
Wholesale price index of manufacturing	None	Partial adjustment	Hendry
Deflator of business sector domestic sales	Adjustment for sales taxes	One year	Linear in logs
Home prices	None	Lagged endogenous variable	Linear in logs
Wholesale price index of manufacturing (excluding food, drink and tobacco)	Adjustment for indirect taxes	Two quarters on foreign and domestic prices	Linear in logs
Unit labour costs in manufacturing	Time trend	Partial adjustment	Hendry
Wholesale price index of manufacturing (excluding food, drink and tobacco)	None	Lagged endogenous variable	First difference in logs
Total current costs	None	One quarter lagged adjustment	Linear in logs
(1) Domestic raw materials costs (2) Normal unit labour costs in manufacturing	Time trend	One half-year	First difference in logs

Table F

West German export and import prices

Model	Dependent variable	Weight of variables[a] Foreign	Domestic	Foreign cost/ price variables in equation
IMF World Trade	UVI for exports of manufactured goods	0.40	0.64	Competitors' export prices
IMF World Trade	Import unit values of manufactures	0.56	0	Competitors' export prices
OECD				
1963-77	Export UVIs	0.50	0.42	Competitors' export average values
1971-77		0.37	0.60	

[a] The weight on the foreign variable represents the coefficient α or β in the model on page 6; the weight on the domestic variable represents the coefficient $(1-\alpha)$ or $(1-\beta)$.

Domestic cost/price variables in equation	Lags on cost/price variables	Form of equation
(1) Domestic raw materials costs (2) Normalised unit labour costs	One half-year	Linear in logs
None	One half-year	Linear in logs
Total current costs	One quarter lagged adjustment	Linear in logs

Table G

Wholesale prices

Model	Dependent variable	Total weight of variables: Foreign [a]	Total weight of variables: Domestic[b]	Foreign cost/ price variable
Bank	Wholesale price index of manufacturing output	0.50	0.63	Price of imports other than finished manufactures
CEPG	Deflator for business sector domestic sales	Ratio of business sector purchases from North Sea and abroad, relative to business sector output in current year	One minus weight on foreign prices	Import costs per unit of import
CGP	Price of domestic absorption	0.29	0.73	UVI for imports
Treasury	Wholesale price index of home output (excluding food, drink and tobacco)	0.37	0.76	UVI for imports excluding food, drink and tobacco and finished manufactures
LBS	Wholesale price index of manufacturing output	0.69	0.28	Index of world wholesale prices
NIESR	Wholesale price index of manufacturing output (excluding food, drink and tobacco)	0.50	0.43	Deflator for imports of goods and services

[a] This represents the coefficient $(1-\gamma)$ on page 7.

[b] This represents the coefficient γ on page 7.

Domestic cost variable	Other variables in equation (excluding dummies)	Lags on cost/price variables	Form of equation
Employment costs per employee in manufacturing	(1) Productivity per employee (2) Indirect taxes	Partial adjustment	Hendry
Domestic costs per unit of output	Time trend	One year	Log linear
Unit labour costs	Indirect taxes	None	Log linear
(1) Trend unit wage costs in manufacturing (2) Nationalised industries prices	Indirect taxes	Three quarters on domestic costs; four quarters on foreign prices	Linear
Unit labour costs in manufacturing	None	Partial adjustment	Hendry
(1) Average earnings (2) Other employment costs (3) Manufacturing productivity	None	Lagged dependent variable	Linear in rates of change

Table H

Earnings

Source	Dependent variable	Price variable
L.A.Dicks-Mireaux (1961) Equation 6	Average wages and salaries Percentage change in annual average	Final (factor sale) prices Percentage change in annual average
L.R.Klein and R.J.Ball (1959) Equation 1e	Index of weekly wage rates Four quarter change	Consumers' prices Four quarter change in four quarter average
F.R.Brechling (1972) Equation 3	Index of weekly wage rates One quarter percentage change	Consumers' prices One quarter percentage change
R.G.Lipsey and M.Parkin (1970)		
(1) Equation 12 (incomes policy 'off')	Index of weekly wage rates Overlapping four quarter percentage change	Retail prices index Overlapping four quarter percentage change
(2) Equation 14 (incomes policy 'on')	Index of weekly wage rates Overlapping four quarter percentage change	Retail prices index Overlapping four quarter percentage change
M.Parkin (1970) Table 2		
(1) Incomes policy 'off' equation	Index of weekly wage rates Overlapping four quarter percentage change	Price expectations Adaptive expectations model based on overlapping four quarter percentage change in retail price index
(2) Incomes policy 'on' equation	Index of weekly wage rates Overlapping four quarter percentage change	Price expectations Adaptive expectations model based on overlapping four quarter percentage change in retail price index
M.T.Sumner (1978) Equationn 4.6	Annual percentage change in weely average wages and salaries	Firms' price expectations
C.J.Johnston and M.C.Timbrell (1973) Equation A2	Annual percentage change in weekly wage rates	Annual percentage change in retail price index
M.Parkin, M.T.Sumner and R.Ward (1976) Equation 3, Table 1	Quarterly percentage change in weekly wage rates	Three measures of price expectations
M.Gray, M.Parkin and M.T.Sumner (1975) Equation 2, Table 4	Annual proportionate change in average wages and salaries	Firms' expected inflation rate
B.T.McCallum (1975) Table III, Case III	One quarter change in log of average earnings	(1) Rational price expectations (2) Price level enters as denominator in real wage term
S.G.B.Henry, M.C.Sawyer and P.Smith (1976) Table 10	One quarter change in log of average wage rates	(1) Lagged one quarter change in retail prices (2) Price level enters as denominator in real earnings term
S.G.B.Henry and P.A.Ormerod (1978) Table 7	Second difference of the log of wage rates	(1) Second difference of the log of prices (2) First difference of the log of lagged real post-tax earnings

[a] The coefficient δ in the model specified in Section 2.

[b] This refers to the longest lag on the level of prices. For example, if the price term enters as a first difference (i.e. $P_t - P_{t-1}$), the longest lag is one period.

Long-run coefficient on prices[a]	Lags on prices[b]	Incomes policy effects	Other variables	Estimation period
0.460	Two years	None	Dow and Dicks-Mireaux Index of pressure of demand for labour	1946-59
0.854	Seven quarters	Dummy for 'political effects'	Unemployment level	1948I-1956IV
0.754	Five quarters	Dummies	Inverse of unemployment rate	1948I-1965IV
0.457	Two quarters	Estimated on policy 'off' data	(1) Change in percentage of labour force unionised (2) Unemployment rate	1948III-1967II (Incomes policy 'off' periods)
0.227	Two quarters	Estimated on policy 'on' data	(1) Change in percentage of labour force unionised (2) Unemployment rate	1948III-1967II (Incomes policy 'on' periods)
0.421	Adaptive expectations	Estimated using policy 'off' data	Unemployment rate	1948III-1969I (Incomes policy 'off' periods)
0.166	Adaptive expectations	Estimated using policy 'on' data	Unemployment rate	1948III-1969I (Incomes policy 'on' periods)
0.514	One year	Dummy	(1) 'Corrected' unemployment rate (2) Percentage change in output per head	1952-65
0.848 or 1.0 if real post-tax average earnings grow by less than 3% per annum	One year directly, but up to four years if real post-tax average earnings grow by less than 3% per annum		(1) Proportion of workers affected by increase (2) Difference between growth in real post-tax earnings and 'desired' rate of growth (3% per annum)	1959-71
1.0 (imposed on sum of coefficients on the three price expectations variables)	One quarter	Dummies	(1) Unemployment rate (2) Tax and national insurance contributions as a proportion of average wage	1956II-1971IV
1.0 (imposed)	One year	Dummy for 'catching up' in 1971-72	(1) Unemployment rate (2) Change in unemployment rate (3) Dummy for uprating of social security payments	1952-74
1.0 (imposed)	One quarter	None	(1) Lagged real earnings (2) Industrial production per head (3) Fraction of labour force force unionised	1956-71
1.0 (imposed)	Two quarters	Dummies	(1) Lagged real post-tax earnings (2) Lag of unemployment	1948I-1974IV
1.0 (imposed)	Three quarters	Policy 'on' dummies and post-policy 'catch-up' dummies	Level of unemployment	1961I-1975II

Table H (continued)

Earnings

Source	Dependent variable	Price variable
Bank model [see Bank of England (1979)]	One quarter proportionate change in average 'normal' weekly average wages and salaries	Lagged four quarter percentage change in consumers' prices
CEPG model [see Fetherston and Coutts (1979)]	Log of average male standard weekly earnings in UK business sector	Consumers' prices
HM Treasury model [see HM Treasury 1979)]	One quarter proportionate change in private sector average earnings	(1) Lagged four quarter percentage change in retail prices (2) Lagged one quarter percentage change in retail prices
LBS model [see London Business School (1979)]	First difference of log of average earnings in manufacturing	(1) First difference and lagged level of wholesale price index of manufacturing output (2) Lagged first difference of log of consumer prices
NIESR model [see National Institute of Economic and Social Research (1979)]	Four quarter percentage change in wage rates	Lagged four quarter percentage change in consumer prices

[a] The coefficient δ in the model specified in Section 2.

[b] This refers to the longest lag on the level of prices. For example, if the price term enters as a first difference (i.e. $P_t - P_{t-1}$), the longest lag is one period.

Long-run coefficient on prices[a]	Lags on prices[b]	Incomes policy effects	Other variables	Estimation period
1.0 (imposed)	Nine quarters	None	(1) 'Target-real-wage' increase (2) Allowance for proportion of workers settling (3) Ratio of post-tax to pre-tax earnings	
1.0 (imposed)	Two years	None	(1) Ratio of manual to non-manual earnings (2) Normal hours (3) Allowance for proportion of workers settling (4) Effective direct tax ratio on income from employment	
1.0 (imposed)	Nine quarters	None	(1) Unemployment rate (2) Change in unemployment rate (3) Change in ratio of post-tax to pre-tax earnings (4) Cyclical adjustment (5) Wage round effect	
1.0 (imposed on wholesale prices)	Two quarters, and lagged level of dependent variable	None	(1) Ratio of real national disposable income to GDP excluding North Sea oil (2) Productivity in manufacturing industry	1963III-1975II
0.685	Lagged dependent variable	None	Unemployment rate	1963I-1978IV

Table J

Simulated effects on cost and price developments of a 10% appreciation in the exchange rate

Variant I

	Number of quarters after exchange rate change						
	1	4	8	12	16	20	Long run
Percentage change from base level in:							
Export prices	-2.2	-6.3	-7.0	-7.3	-7.6	-7.7	-7.9
Domestic prices	-1.0	-3.1	-4.1	-4.8	-5.2	-5.4	-5.7
Earnings	-0.2	-1.1	-2.4	-3.2	-3.7	-3.9	-4.3
Real earnings	0.9	2.0	1.7	1.6	1.5	1.5	1.4
Export and import cost competitiveness[a]	-9.8	-8.9	-7.6	-6.8	-6.3	-6.1	-5.7
Export price competitiveness[b]	-7.8	-3.7	-3.0	-2.7	-2.4	-2.3	-2.1
Import price competitiveness[c]	-9.0	-6.9	-5.9	-5.2	-4.8	-4.6	-4.3
Terms of trade	7.8	3.7	3.0	2.7	2.4	2.3	2.1

Note: The full specification of variant I is described in the appendix.

[a] The difference between the change in the exchange rate (10% throughout) and the change in earnings.

[b] The difference between the change in UK import prices (i.e. competitors' export prices) and in UK export prices.

[c] The difference between the change in import prices and domestic prices.

Table K

Simulated effects on cost and price developments of a 10% appreciation in the exchange rate

Variant II

	Number of quarters after exchange rate change					
	1	4	8	12	16	Long run
Percentage change from base level in:						
Export prices	-3.0	-7.4	-8.6	-9.3	-9.6	-10.0
Domestic prices	-1.8	-5.2	-7.4	-8.6	-9.3	-10.0
Earnings	-0.5	-3.5	-6.6	-8.2	-9.0	-10.0
Real earnings	1.3	1.7	0.9	0.5	0.2	0.0
Export and import cost competitiveness[a]	-9.5	-6.5	-3.4	-1.8	-1.0	0.0
Export price competitiveness[b]	-7.0	-2.6	-1.4	-0.7	-0.4	0.0
Import price competitiveness[c]	-8.2	-4.8	-2.6	-1.4	-0.7	0.0
Terms of trade	7.0	2.6	1.4	0.7	0.4	0.0

Note: The full specification of variant II is described in the appendix.

[a] The difference between the change in the exchange rate (10% throughout) and the change in earnings.

[b] The difference between the change in UK import prices (i.e. competitors' export prices) and in UK export prices.

[c] The difference between the change in import prices and domestic prices.

Table L

Simulated effects on cost and price developments of a 10% appreciation in the exchange rate

Variant III

	Number of quarters after exchange rate change					
	1	2	3	4	8	Long run
Percentage changes from base level in:						
Export prices	-4.4	-7.9	-9.0	-9.4	-10.0	-10.0
Domestic prices	-4.9	-7.9	-8.7	-9.3	-9.9	-10.0
Earnings	-1.9	-4.6	-6.8	-8.4	-9.9	-10.0
Real earnings	2.9	3.3	1.9	0.9	0.1	0.0
Export and import cost competitiveness[a]	-8.1	-5.4	-3.2	-1.6	-0.1	0.0
Export price competitiveness[b]	-5.6	-2.1	-1.0	-0.6	0.0	0.0
Import price competitiveness[c]	-5.1	-2.1	-1.3	-0.7	-0.1	0.0
Terms of trade	5.6	2.1	1.0	0.6	0.0	0.0

Note: The full specification of variant III is described in the appendix.

[a] The difference between the change in the exchange rate (10% throughout) and the change in earnings.

[b] The difference between the change in UK import prices (i.e. competitors' export prices) and in UK export prices.

[c] The difference between the change in import prices and domestic prices.

Table M

The impact of a 10% appreciation: results from the Bank's short-term economic model

	Number of quarters after exchange rate change				
	1	4	8	12	14
Percentage change from base level in:					
AVI of exports of goods and services	- 3.3	- 6.7	- 8.0	- 8.7	- 8.9
AVI of imports of goods and services	- 8.9	-10.3	-10.5	-10.6	-10.7
Wholesale prices	-	- 3.2	- 5.4	- 7.0	- 7.6
Consumer prices	- 0.2	- 2.1	- 3.9	- 5.3	- 5.9
Earnings	0.1	- 1.2	- 2.8	- 4.3	- 4.9
Real earnings	0.3	0.9	1.1	1.0	1.0
Export and import cost competitiveness	-10.0	- 9.4	- 7.9	- 6.3	- 5.7
Export price competitiveness	- 7.7	- 4.2	- 2.4	- 1.5	- 1.2
Import price competitiveness	- 6.3	- 4.5	- 3.3	- 2.4	- 2.1
Terms of trade in goods and services	5.6	3.6	2.5	1.9	1.8

Appendix

Specifications of the variants used in the simulations

63 The three variants used are intended to illustrate a process of slow transmission of costs and prices (variant I); a medium-paced transmission (variant II); and a fast transmission (variant III). The initial shock to all these variants is provided by a once-for-all 10% revaluation of the sterling exchange rate.

64 All three variants are derived from the relatively simple model set out in Section 2. The values assigned to the coefficients and time-lags are broadly in keeping with the range of empirical evidence and are set out in Table N below. The simulations generated by each of the three variants are entirely mechanistic and do not reflect the subsequent impact of a change in the exchange rate on the level of output or on the exchange rate itself.

Table N

Long-run coefficients and lag structures used for:

Variant I

$\alpha = 0.5$	$\gamma = 0.75$	$\delta = 0.75$		
$\alpha_0 = 0.2$	$\gamma_0 = 0.3$	$\delta_0 = 0.15$	$\delta_3 = 0.10$	$\delta_6 = 0.05$
$\alpha_1 = 0.2$	$\gamma_1 = 0.225$	$\delta_1 = 0.13$	$\delta_4 = 0.08$	$\delta_7 = 0.03$
$\alpha_2 = 0.1$	$\gamma_2 = 0.15$	$\delta_2 = 0.12$	$\delta_5 = 0.07$	$\delta_8 = 0.02$
	$\gamma_3 = 0.075$			

Variant II

$\alpha = 0.5$	$\gamma = 0.666$	$\delta = 1.0$	
$\alpha_0 = 0.25$	$\gamma_0 = 0.333$	$\delta_0 = 0.286$	$\delta_3 = 0.143$
$\alpha_1 = 0.25$	$\gamma_1 = 0.222$	$\delta_1 = 0.238$	$\delta_4 = 0.095$
	$\gamma_2 = 0.111$	$\delta_2 = 0.19$	$\delta_5 = 0.048$

Variant III

$\alpha = 0.667$	$\gamma = 0.333$	$\delta = 1.0$	
$\alpha_0 = 0.444$	$\gamma_0 = 0.222$	$\delta_0 = 0.4$	$\delta_2 = 0.2$
$\alpha_1 = 0.223$	$\gamma_1 = 0.111$	$\delta_1 = 0.3$	$\delta_3 = 0.1$

Note: In all three variants $\beta = 1$ with no lag.

Bibliography

ALLEN, R.A. and BROWN, R.N. 1978. 'The terms of trade'. Bank of England Quarterly Bulletin, 18(3), 365-70.

ARTIS, M.J. 1971 'Some aspects of the present inflation and the National Institute Model' The Current Inflation, editors H.G.Johnson and A.R.Nobay, 3-37. London: Macmillan.

ARTIS, M.J. and MILLER, M.H. 1977. 'Inflation and real wages'. A paper prepared for presentation to the Academic panel of HM Treasury, July 1977, mimeographed, University of Manchester.

ARTIS, M.J., TEMPLE, P. and COPELAND, L. 1977. 'Wage equations'. A paper prepared for the seminar on UK Wage/Earnings Price Inflation held at the University of Manchester, June 1977, mimeographed, University of Manchester.

ARTUS, J.R. 1974. 'The behavior of export prices for manufactures'. International Monetary Fund Staff Papers, 21, 583-604.

ASHENFELTER, O. and PENCAVEL, J.H. 1975. 'Wage changes and the frequency of wage settlements'. Economica, 42(166), 162-70.

BALL, R.J. 1962. 'The prediction of wage-rate changes in the United Kingdom economy 1957-1960'. Economic Journal, 72, 27-44.

BALL, R.J., BURNS, T. and LAURY, J.S.E. 1977. 'The role of exchange rate changes in balance of payments adjustment - the United Kingdom case'. Economic Journal, 87, 1-29.

BANK OF ENGLAND. 1979. 'Bank of England model of the UK economy'. Bank of England Discussion Paper, No.5.

BARKER, T.S. 1976. (Editor) Economic Structure and Policy. London: Chapman and Hall.

BARKER, T.S., PETERSON W., and WINTERS A. 1979. 'The Cambridge multisectoral dynamic model. Cambridge University, Department of Applied Economics, Growth Project Paper 470.

BATCHELOR, B.A. 1977. 'The stability of the export sector under alternative exchange rate regimes'. Paper presented to the Seminar on Export Forecasting, University of Warwick.

BEATH, J. 1978. 'Alternative theories of price formation and their implications for the short-run behaviour of company profits'. Cambridge University, Department of Applied Economics, Growth Project Paper 458.

BLACK, S.W. and KELEJIAN, H.H. 1972. 'The formulation of the dependent variable in the wage equation'. Review of Economic Studies, 39, 55-9.

BRECHLING, F.P.R. 1972. 'Some empirical evidence on the effectiveness of prices and incomes policies'. In Incomes policy and inflation, editors M.Parkin and M.T.Sumner. Manchester: Manchester University Press.

BURROWS, P. and HITIRIS, T. 1972. 'Estimating the impact of incomes policy'. Bulletin of Economic Research, 24(1), 42-51. Reprinted in Incomes policy and inflation, editors M.Parkin and M.T.Sumner. 1972. Manchester: Manchester University Press.

CARLSON, J.A. and PARKIN, M. 1975. 'Inflation expectations'. Economica, 42, 123-38. Reprinted as 'Consumers' price expectations'. In Inflation in the United Kingdom, editor M.Parkin and M.T.Sumner. 1978. Manchester: Manchester University Press.

COGHLAN, R.T. 1979. 'A small monetary model of the UK Economy. Bank of England Discussion Paper, No.3.*

CONFEDERATION OF BRITISH INDUSTRY. 1978. Business views on exchange rate policy. London: Confederation of British Industry.

COOPER, R.A., HARTLEY, K. and HARVEY, C.R.M. 1970. Export performance and the pressure of demand. London: George Allen and Unwin.

COUTTS, K., GODLEY, W. and NORDHAUS, W. 1978. Industrial pricing in the United Kingdom. University of Cambridge, Department of Applied Economics, Monographs: 26. Cambridge: Cambridge Univesity Press.

CROSS, R.J. and LAIDLER, D. 1976. 'Inflation, excess demand and expectations in fixed exchange rate open economies: some preliminary empirical results'. In Inflation in the World Economy. Manchester: Manchester University Press.

DAVIDSON, J.E.H., HENDRY, D.F., SRBA, F. and YEO, S. 1978. 'Econometric modelling of the aggregate time-series relationship between consumers' expenditure and income in the United Kingdom'. Economic Journal, 88, 661-92.

DEPPLER, M.C. and RIPLEY, D.M. 1978. 'The world trade model: merchandise trade'. International Monetary Fund Staff Papers, 25(1), 147-206.

DICKS-MIREAUX, L.A. 1961. 'The interrelationship between cost and price changes, 1946-1959: a study of inflation in post-war Britain'. Oxford Economic Papers, 13, 267-92.

DICKS-MIREAUX, L.A. and DOW, J.C.R. 1959. 'The determinants of wage inflation: United Kingdom, 1946-56'. Journal of the Royal Statistical Society, 122 (2), 145-84.

DOW, J.C.R. and DICKS-MIREAUX, L.A. 1958. 'The excess demand for labour: a study of conditions in Great Britain 1946-56'. Oxford Economic Papers, 10, 1-33.

*This paper is no longer available from the Bank, but photocopies can be obtained from University Microfilms International; see the inside of the front cover of this paper.

ECKSTEIN, O. and FROMM, G. 1968. 'The price equation'. American Economic Review, 58, 1159-83.

THE ECONOMIST. 1977. 'The car-price carousel'. The Economist, 262(6963) 72-3.

EDGREN, G., FAXEN, K-O., and ODHNER, C-E. 1969. 'Wages, growth and the distribution of income'. Swedish Journal of Economics, 71(3), 133-60.

ENOCH, C.A. 1978. 'Measures of competitiveness in international trade'. Bank of England Quarterly Bulletin, 18(2) 181-95.

FETHERSTON, M.J. 1975. 'Overlapping observations and lagged dependent variables in the analysis of wage and price changes'. Cambridge University, Department of Applied Economics, Cambridge Economic Policy Group, Discussion Paper No.2.

FETHERSTON, M.J. and COUTTS, K.J. 1979. Technical manual of the CEPG model of the UK. Cambridge University, Department of Applied Economics, Cambridge Economic Policy Group.

FOSTER, J. and GREGORY, M. 1977. 'Inflation expectations: the use of qualitative survey data'. Applied Economics, 9(4) 319-29.

GODFREY, L.G. 1972. 'The Phillips' curve: incomes policy and trade union effects'. In The Current Inflation, editors H.G.Johnson and A.R.Nobay. London: Macmillan. Abridged, amended and reprinted as 'Some comments on the estimation of the Lipsey-Parkin inflation model'. In Incomes policy and inflation, editors M.Parkin and M.T.Sumner. 1972. Manchester: Manchester University Press.

GODFREY, L. and TAYLOR, J. 1973. 'Earnings changes in the United Kingdom 1954-70: excess labour supply, expected inflation and union influence'. Oxford Bulletin of Economics and Statistics, 35, 197-216.

GODLEY, W.A.H. and ROWE, D.A. 1964. 'Retail and consumer prices, 1955-1963'. National Institute Economic Review, No.30, 44-57.

GOLDSTEIN, M. 1972. 'The trade-off between inflation and unemployment: a survey of the econometric evidence for selected countries'. International Monetary Fund Staff Papers, 19, 647-98.

GOLDSTEIN, M. 1974. 'The effect of exchange rate changes on wages and prices in the United Kingdom: an empirical study'. International Monetary Fund Staff Papers, 21, 694-739.

GOLDSTEIN, M.S. 1977. 'Downward price inflexibility, ratchet effects and the inflationary impact of import price changes in some empirical evidence'. International Monetary Fund Staff Papers, 24, 569-612.

GOLDSTEIN, M.S. and KHAN, M.S. 1974. 'The relative stability of selected wage inflation models for the United Kingdom'. Unpublished International Monetary Fund Working Paper.

GRANGER, C.W.J. and NEWBOLD, P. 1974. 'Spurious regressions in econometrics'. Journal of Econometrics, 2(2), 111-20.

GRAY, M.R., PARKIN, M. and SUMNER, M.T. 1975. 'Inflation in the United Kingdom: causes and transmission mechanisms'. Paper presented at the Conference on The Monetary Mechanism in Open Economics, Helsinki, Finland.

HAGUE, D.C., OAKESHOTT, E. and STRAIN, A. 1974. Devaluation and pricing decisions. London: George Allen and Unwin.

HENRY, S.G.B. and ORMEROD, P.A. 1978. 'Incomes policy and wage inflation: empirical evidence for the UK 1961-1977'. National Institute Economic Review, No.85, 31-9.

HENRY, S.G.B., SAWYER, M.C. and SMITH, P. 1976. 'Models of inflation in the United Kingdom: an evaluation'. National Institute Economic Review, No.77, 60-71.

HINES, A.G. 1964. 'Trade unions and wage inflation in the United Kingdom, 1893-1961'. Review of Economic Studies, 31, 331-52.

HINES, A.G. 1968. 'Unemployment and the rate of change of money wage rates in the United Kingdom, 1862-1963: a reappraisal'. Review of Economics and Statistics, 50, 60-7.

HINES, A.G. 1971. 'The determinants of the rate of change of money wage rates and the effectiveness of incomes policy'. In The Current Inflation, editors H.G.Johnson and A.R.Nobay. London: Macmillan.

HM TREASURY. 1979. HM Treasury macroeconomic model: technical manual. London: HM Treasury.

HOLMES, P.M. 1978. Industrial Pricing Behaviour and Devaluation. London: Macmillan.

ISARD, P. 1977. "How far can we push the 'law of one price'?". American Economic Review, 67(5), 942-48.

JOHNSTON, J. and TIMBRELL, M. 1973. 'Empirical tests of a bargaining theory of wage-rate determination', Manchester School, 41(2), 141-67. Reprinted in Inflation and labour markets, editors D.E.W.Laidler and D.Purdy. 1975. Manchester: Manchester University Press.

KHAN, M.S. 1977. 'The variability of expectations in hyperinflations'. Journal of Political Economy, 85(4), 817-27.

KLEIN, L.R. and BALL, R.J. 1959. 'Some econometrics of the determination of absolute prices and wages'. Economic Journal, 9, 465-82.

KRAFT, A. and KRAFT, J. 1974. 'A re-estimation of the Phillips' curve for the United Kingdom'. Applied Economics, 6(3) 215-27.

KREININ, M.E. 1977. 'The effect of exchange rate changes on the prices and volumes of foreign trade'. International Monetary Fund Staff Papers, 24, 297-329.

KUH, E. 1967. 'A productivity theory of wage levels - an alternative to the Phillips' curve'. Review of Economic Studies, 34, 333-60.

LAIDLER, D.E.W. 1976. 'Inflation in Britain: a monetarist perspective'. American Economic Review, 66(4), 485-500.

LAIDLER, D.E.W. and PARKIN, J.M. 1975. 'Inflation - a survey'. Economic Journal, 85, 741-809.

LAURY, J.S.E., LEWIS, G.R. and ORMEROD, P.A. 1978. 'Properties of macroeconomic models of the UK economy: a comparative study'. National Institute Economic Review, No.83, 52-72.

LEWIS, P.E.T. and MAKEPEACE, G.H. 1978. 'Union activity and wage inflation in the UK (1949-1976)'. Lanchester Polytechnic, Department of Economics, Staff Seminar Discussion Paper, No.9.

LIPSEY, R.G. 1960. 'The relation between unemployment and the rate of change of money wage rates in the United Kingdom, 1862-1957: a further analysis'. Economica, 27, 1-31.

LIPSEY, R.G. and STEUER, M.D. 1961. 'The relation between profits and wage rates'. Economica, 28, 137-55.

LIPSEY, R.G. and PARKIN, J.M. 1970. 'Incomes policy: a re-appraisal'. Economica, 37, 115-38. Reprinted in Incomes policy and Inflation, editors M.Parkin and M.T.Sumner. 1972. Manchester: Manchester University Press.

LLEWELLYN, G.E.J. 1974. 'The determinants of United Kingdom import prices'. Economic Journal, 84, 18-31.

LONDON BUSINESS SCHOOL. 1979. LBS Quarterly Econometric Model of the United Kingdom Economy. London: London Business School.

MACKAY, D.I. and HART, R.A. 1974. 'Wage inflation and the Phillips relationship'. Manchester School, 42(2), 295-312.

McCALLUM, B.T. 1970. 'The effect of demand on prices in British manufacturing: another view', Review of Economic Studies, 37(I)(109), 147-55.

McCALLUM, B.T. 1974. 'Wage rate changes and the excess demand for labour; an alternative formulation'. Economica, 41, 269-77.

McCALLUM, B.T. 1975. 'Rational expectations and the natural rate hypothesis: some evidence for the United Kingdom'. Manchester School, 43(1), 56-67.

MINFORD, P. and BRECH, M. 1979. 'The wage equation and rational expectations'. Paper presented at the AUTE annual conference, mimeographed, University of Liverpool.

MUTH, J.F. 1961. 'Rational expectation and the theory of price movements'. Econometrica, 29, 315-35.

NATIONAL INSTITUTE OF ECONOMIC AND SOCIAL RESEARCH. 1977. The structure and properties of the NIESR model.

NATIONAL INSTITUTE OF ECONOMIC AND SOCIAL RESEARCH. 1979. 'Listing of the interim NIESR model IV'. National Institute Discussion Paper, No.28.

NEILD, R.R. 1963. 'Pricing and employment in the trade cycle'. National Institute of Economic and Social Research Occasional Papers, No.21. Cambridge: Cambridge University Press.

NORDHAUS, W.D. 1972. 'Recent developments in price dynamics'. In The Econometrics of Price Determination, editor O.Eckstein. Washington: Board of Governors of the Federal Reserve System, 16-49.

ODLING-SMEE, J. and HARTLEY, N. 1978. 'Some effects of exchange rate changes'. Government Economic Service Working Paper No.2 (Treasury Working Paper No.2). London: HM Treasury.

OECD SECRETARIAT. 1978. 'Competitive position, export pricing, and trade performance', DES/NI(78)13.

ORMEROD, P.A. 1979. "Manufactured export prices in the United Kingdom and the 'law of one price'". National Institute of Economic and Social Research Discussion Paper, No.27.

ORMEROD, P.A. and HENRY, S.G.B. 1979. 'Rational expectations in a wage-price model of the UK economy'. Paper presented at SSRC Conference on Rational Expectations in Economic Models.

PARKIN, M. 1970. 'Incomes policy: some further results on the determination of the rate of change of money wages'. Economica, 37, 386-401. Reprinted as 'Some further results on the rate of change in money wages'. In Incomes Policy and Inflation, editors M.Parkin and M.T.Sumner. 1972. Manchester: Manchester University Press.

PARKIN, M. 1975. 'The causes of inflation: recent contributions and current controversies'. In Current Economic Problems, editors M.Parkin and A.R.Nobay. Cambridge: Cambridge University Press. Revised and reprinted as 'Alternative explanations of United Kingdom inflation: a survey'. In Inflation in the United Kingdom, editors M.Parkin and M.T.Sumner, 11-51. 1978. Manchester: Manchester University Press.

PARKIN, M., SUMNER, M.T. and WARD, R. 1976. 'The effects of excess demand, generalized expectations and wage-price controls on wage inflation in the UK: 1956-71'. In The Economics of Price and Wage Controls. Carnegie-Rochester Conference Series on Public Policy Vol.2, editors K.Brunner and A.H.Meltzer. Oxford: North-Holland.

PHILLIPS, A.W. 1958. 'The relation between unemployment and the rate of change of money wage rates in the United Kingdom, 1861-1957'. Economica, 25, 283-99.

PIGOTT, C., SWEENEY, R.J. and WILLETT, T.D. 1975. 'Some aspects of the behaviour and effects of flexible exchange rates'. Paper presented at the Conference of Monetary Theory and Policy, Konstanz.

PURDY, D.L. and ZIS, G. 1973. 'Trade unions and wage inflation in the UK: a re-appraisal'. In Essays in Modern Economics, editor M.Parkin. London: Longman. Reprinted in Inflation and labour markets, editors D.E.W.Laidler and D.Purdy. 1974. Manchester: Manchester University Press.

ROSENDALE, P.B. 1973. 'The short-run pricing policies of some British engineering exporters'. National Institute Economic Review, No.65, 44-51.

ROWLEY, J.C.R. and WILTON, D.A. 1973. 'Quarterly models of wage determination: some efficient estimates'. American Economic Review, 63, 380-89.

RUSHDY, F. and LUND, P.J. 1967. 'The effect of demand on prices in British manufacturing industry'. Review of Economic Studies, 34(3), 361-73.

SANTOMERO, A.M. and SEATER, J.J. 1978. 'The inflation-unemployment trade-off: a critique of the literature'. Journal of Economic Literature, 16, 499-544.

SARGAN, J.D. 1964. 'Wages and prices in the United Kingdom: a study in econometric methodology'. In Econometric Analysis for National Economic Planning, Colston Papers, Vol.16, editors P.E.Hart, G.Mills and J.K.Whittaker. Bristol: Butterworths Scientific Publications.

SARGAN, J.D. 1977. 'A model of wage-price inflation'. Mimeographed, London School of Economics.

SAUNDERS, P.G. and NOBAY, A.R. 1972. 'Price expectations, the Phillips' curve and incomes policy'. In Incomes policy and inflation, editors M.Parkin and M.T.Sumner. Manchester: Manchester University Press.

SMITH, D.C. 1968. 'Incomes policy'. Chapter 3 in Britain's Economic Prospects, by R.E.Caves and Associates. Washington: The Brookings Institution; London: George Allen and Unwin. Reprinted in Incomes policy and inflation, editors M.Parkin and M.T.Sumner. 1972. Manchester: Manchester University Press.

SMITH, G.W. 1978(a). 'Price determination'. In Inflation in the United Kingdom, editors M.Parkin and M.T.Sumner, 93-111. Manchester: Manchester University Press.

SMITH, G.W. 1978(b). 'Producers' price and cost expectations'. In Inflation in the United Kingdom, editors M.Parkin and M.T.Sumner, 141-65. Manchester: Manchester University Press.

SOLOW, R.M. 1969. 'Price expectations and the behaviour of the price level. Manchester: Manchester University Press.

SUMNER, M.T. 1972. 'Aggregate demand, price expectations and the Phillips' Curve'. In Incomes policy and inflation, editors M.Parkin and M.T.Sumner. Manchester: Manchester University Press.

SUMNER, M.T. 1978. 'Wage determination'. In Inflation in the United Kingdom, editors M.Parkin and M.T.Sumner, 75-92. Manchester: Manchester University Press.

TAYLOR, J. 1970. 'Hidden unemployment, hoarded labour, and the Phillips' Curve'. Southern Economic Journal, 37(1), 1-16.

TAYLOR, J. 1974. Unemployment and wage inflation: with special reference to Britain and the USA. London: Longman.

THOMAS, R.L. and STONEY, P.J.M. 1970. 'A note on the dynamic properties of the Hines inflation model'. Review of Economic Studies, 37, 286-94.

THYGESEN, N. 1978. 'Inflation and exchange rates: evidence and policy guidelines for the European Community'. Journal of International Economics, 8(2), 301-18.

TURNER, P.P. 1976. 'Some effects of devaluation: a study based on the UK's trade in manufactured goods'. Unpublished Harvard University dissertation.

WALLIS, K.F. 1971. 'Wages, prices and incomes policies: some comments'. Economica, 38, 304-9. Reprinted in Incomes Policy and Inflation, editors M.Parkin and M.T.Sumner. 1972. Manchester: Manchester University Press.