Bank of England

Discussion Paper No 18

Two studies of commodity price behaviour:

Interrelationships between commodity prices

by

Mrs J L Hedges

and

Short-run pricing behaviour in commodity markets

by

C A Enoch

November 1981

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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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Contents

Introduction[1]

1 This discussion paper contains two studies of commodity prices that have been carried out in the Economics Division of the Bank of England as part of continuing work to attempt to explain price developments in commodity markets.

2 The first study uses the correlations between the year-on-year changes in prices of forty-three individual commodities in the period 1968-80 to classify these commodities into a number of groupings. It then looks at the characteristics of these groupings and at changes over time in their relationships, and considers possible explanations for these changes.

3 The second study looks at daily data on prices for four commodities during a period of eight months in 1979-80 to see if there is any evidence of short-run instability in these markets during this period. Two alternative models of price determination are presented. Evidence for this type of instability is found only for one of the commodities - copper - and only using one of the models. There is also some evidence of overspill from prices of precious metals to commodity prices.

[1] The authors are indebted to W A Allen, I D Bond, R N Brown J S Flemming, B W Gunn, G Hacche, P L Joyce, D Newbery, M Panic, J C Townend and C B Wright for comments and suggestions on earlier drafts.

Interrelationships between commodity prices

by

Mrs J L Hedges

Contents

1

Introduction

1 Forecasting the current account of the UK balance of payments involves, among other things, taking a view on the likely movement of commodity prices on world markets. This is necessary because more than a fifth of total UK imports in 1980, for example, were accounted for by non-oil primary products; this increases to nearly a half once semi-processed industrial raw materials are included. Clearly it would be impracticable to produce forecasts of the price of each commodity separately. For this reason, prices of commodities are commonly weighted together into aggregate commodity price indices; movements in these aggregate indices are then predicted, using econometric models constructed to explain their response to various influences in the past.

2 This paper reports the results of a study of the interrelationships between the price movements of forty three industrial raw materials and foods imported by the United Kingdom. It describes the patterns of associations observed in their price movements, examines some of the factors which may make prices move together, and briefly describes the way in which these associations appear to have changed since the late 1960s. It is hoped that a more detailed knowledge of the interdependence of commodity price movements will eventually facilitate future studies of their behaviour as well as the construction of aggregate price indices more satisfactory than those currently in use. This, in turn, should enhance forecasters' ability to predict the prices at which primary commodities enter the United Kingdom.

3 The analysis is based on simple correlation coefficients used to test the degree of association between different price movements. Simple correlation will not, of course, identify the direction of causation; nor will it distinguish the effects of direct linkages, such as joint production or consumer substitution, from those of common causes, such as world inflation or seasonality. This basic technique

is selected in preference to more sophisticated methods[1] because it is suitable for processing the large amount of data used in the exercise. Whilst it may be open to a number of methodological criticisms it is, nevertheless, felt to be adequate for the purpose of this exercise and yields useful results.

4 By making prior adjustments to the data we can make allowances for several possible common causes and thus come close to measuring the direct links between prices. For many purposes, however, it is sufficient to measure the association between two prices without distinguishing between common causes and direct links. For this reason, the results reported are given with a minimum of prior adjustments.

5 In order to eliminate seasonal factors, prices are expressed as percentage changes between the average price during each quarter and the corresponding quarter a year earlier throughout the paper. A further test is constructed by adjusting the data for world inflation and exchange rate fluctuations. The results for the 'real' (inflation adjusted) price correlations are discussed along with those using 'nominal' prices. In the course of the analysis, sub-groups of commodities are formed on the basis of prior knowledge of individual markets and statistically significant correlations (in both nominal and real terms). The possible influence of exchange rate fluctuations is treated separately in a later section.

[1] For a discussion on the methodology of cross-spectral analysis, for example, see Labys and Granger (1970).

Details of the tests

6 The cross correlation coefficients are calculated for the forty-three individual commodities which make up the UK-weighted aggregate price indices used in the Bank.[1] The correlations are computed for nominal and real [2] indices over the period 1968 I-1980 IV and for the two sub-periods 1968 I-1973 IV and 1974 I-1980 IV. Earlier research [3] has pointed to changing behaviour in commodity markets during the 1970s. The exact choice of sub-periods used in this paper is to some extent arbitary, although they do correspond to periods of relatively rapid and relatively depressed economic growth. The critical values of the significance test for the whole period are 0.28 and 0.23 (at the 5% and 10% levels) and for the sub-periods they are 0.38 and 0.33 respectively.

7 In general, the real price correlations are lower than their equivalent nominal coefficients, as might be expected, since all the nominal prices are subject to similar inflationary pressures; there are, however, exceptions. In the course of the analysis, commodities were divided into small groups linked by shared characteristics. Such a division could be performed in numerous ways and so the criteria applied had inevitably to be arbitrary to some extent. At one extreme, groups could be formed using prior knowledge of technological, economic or institutional interdependence: at the other, only statistical criteria (for example, minimising the number of groupings subject to a 'goodness of fit' constraint) might be applied. In this exercise a middle course has been steered: while statistical criteria have been applied throughout, prior knowledge of the characteristics of the commodities has also been taken into account.

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[1] Many of these series are derived from price quotes as near as possible to those used in the UN indices.

[2] Expressed relative to the world export price of manufactured goods.

[3] Enoch and Panic (1981), and OECD (1981).

8 The starting point is to find a 'bench mark' group against which other commodity prices could be measured for the whole period (1968-80). The commodities in this 'bench mark' group would need to be freely traded in well ordered markets and should exhibit high cross correlation in both nominal and real prices.

(a) Initially the four base metals (copper, tin, lead and zinc) were chosen to form this bench mark group. They are all traded on the London Metal Exchange, which is the main world trading market for these metals. Investment in the base metals has always been a popular alternative to holding financial assets and this has led their prices to move closely together. The base metal ores and scraps were also tested for inclusion in the bench mark group, but resulting cross correlation show that the ores and tin scrap tend to move differently. Copper, lead and zinc scraps are, however, closely correlated both with the prices of their own metals and with the other base metals and scraps, so the bench mark group is composed of these seven commodities. Each component's correlation with an index compiled from an aggregate of this group using UK import weights (denoted Group A) is high and positive, ranging from 0.62 to 0.99. The cross correlations between the components range from 0.47 to 0.95 (see table opposite). In real terms, the correlations of the individual metals and scraps are slightly lower but still significant, ranging from 0.55 to 0.98 with the index and from 0.39 to 0.94 amongst the components.

(b) The next step was to analyse the correlation of Group A's total index with the remaining thirty-six commodities. Fifteen commodities exhibit a significant positive correlation with Group A in both nominal and real terms but, within this Group, three have few significant cross correlations. Twelve commodities - steel scrap, aluminium scrap, rubber, hardwood, lumber, cotton, sisal, lard, soya beans, soya oil, wheat and maize - have high correlations with Group A (ranging from 0.53 to 0.81 in nominal terms and from 0.43 to 0.77 in real) and are significantly correlated with each other, in some cases quite highly. The correlation of the components of these (Group B) with an index formed from them is high (0.54 to 0.92) in

GROUP A

CROSS CORRELATIONS

		1	2	3	4	5	6	7	8
1	Copper	1.000							
2	Lead	0.697	1.000						
3	Zinc	0.787	0.536	1.000					
4	Tin	0.532	0.659	0.621	1.000				
5	Copper scrap	0.949	0.658	0.765	0.466	1.000			
6	Lead scrap	0.715	0.753	0.528	0.591	0.786	1.000		
7	Zinc scrap	0.773	0.661	0.885	0.679	0.747	0.666	1.000	
8	Group A	0.986	0.762	0.851	0.616	0.939	0.740	0.836	1.000
	Group A in real terms	0.984	0.729	0.795	0.546	0.924	0.707	0.784	1.000

GROUP B

CROSS CORRELATIONS

		1	2	3	4	5	6	7	8	8	10	11	12	13
1	Steel scrap	1.000												
2	Aluminium scrap	0.620	1.000											
3	Rubber	0.486	0.754	1.000										
4	Hardwood	0.395	0.364	0.659	1.000									
5	Lumber	0.349	0.505	0.794	0.633	1.000								
6	Cotton	0.412	0.522	0.750	0.675	0.703	1.000							
7	Sisal	0.691	0.518	0.623	0.673	0.693	0.514	1.000						
8	Lard	0.573	0.337	0.585	0.586	0.465	0.404	0.567	1.000					
9	Soya beans	0.445	0.348	0.547	0.529	0.697	0.654	0.607	0.658	1.000				
10	Soya oil	0.677	0.406	0.543	0.656	0.512	0.583	0.694	0.868	0.800	1.000			
11	Wheat	0.630	0.403	0.746	0.733	0.661	0.682	0.768	0.675	0.621	0.726	1.000		
12	Maize	0.563	0.456	0.716	0.668	0.638	0.587	0.751	0.683	0.690	0.727	0.821	1.000	
13	Group B	0.630	0.543	0.842	0.785	0.810	0.761	0.824	0.761	0.797	0.826	0.920	0.916	1.000
	Group B in real terms	0.545	0.497	0.817	0.700	0.731	0.711	0.751	0.648	0.741	0.726	0.872	0.901	1.000
	Group A in real terms	0.672	0.709	0.771	0.570	0.561	0.637	0.613	0.496	0.432	0.511	0.621	0.569	0.735

nominal terms and only marginally lower in real (see table opposite). Within the cross correlations rubber has a very high positive correlation with cotton, timber, wheat and maize, while wheat and maize also have high correlations with lumber, soya beans and soya oil. All of these raw materials and foodstuffs, as we have seen, move closely with the base metals. This is perhaps not surprising for rubber, as 70% of the world's production is used by the motor industry, and also for timber, which is a basic material for many varied industries. The reasons for the relationship between foodstuffs and the base metals are, however, less obvious. The high positive correlation of wheat and maize with soya products may reflect, at least in part, consumer substitution.

(c) From the twenty-four remaining commodities no clear group with shared characteristics could be established from associations with either Group A or Group B. From a closer examination of the outstanding indices we find that tropical beverages form a distinct group - Group C - comprising coffee, cocoa and tea which exhibit high cross correlations of about 0.6, largely reflecting consumer and producer substitutability. The correlations of these components with a beverage index average around 0.85. The components are mainly uncorrelated with other commodities. In real terms, the correlations of the beverages among themselves are marginally but not significantly increased. We also find that coffee is significantly correlated with tungsten ore and aluminium scrap at the 5% level. Cocoa has a positive correlation with the base metals, rubber, the wools, cotton, timber, maize and soya beans. Tea is significantly correlated with tin, aluminium and soya beans, all at around 0.5.

Group C

Cross correlations

		1	2	3	4
1	Coffee	1.000			
2	Cocoa	0.627	1.000		
3	Tea	0.621	0.585	1.000	
4	Group C	0.854	0.854	0.862	1.000
	Group C in real terms	0.876	0.861	0.864	1.000

(d) Steel bars and steel sheets were found to have a high cross correlation (0.53 nominal, 0.48 real) and were used to form the next index (Group D). This steel aggregate is uncorrelated with the base metals (Group A) but registers a number of significant and near significant correlations, positive and negative, with a number of other metals and ores. Bauxite, chrome ore, tungsten ore and aluminium are all positively correlated with Group D, although they have few significant cross correlations amongst themselves. We therefore treat them as two separate groupings: bauxite with chrome ore and tungsten ore with aluminium.

Group D

Cross correlations

		1	2	3
1	Iron and steel sheets	1.000		
2	Iron and steel bars	0.582	1.000	
3	Group D	0.878	0.869	1.000
	Group D in real terms	0.808	0.905	1.000
	Group C	0.260	0.277	0.320

(e) Bauxite and chrome ore (Group E opposite) are significantly correlated and their joint index is significantly correlated with the steel index (Group D). Chrome is widely applied as an anti-corrosive in steel products but the reasons for the link between steel and bauxite are less clear. Both ores exhibit predominantly negative correlations outside Group D, probably reflecting long lags in response to the economic cycle. Bauxite, for example, is a transfer price mainly traded between the subsidiaries of Alcan on long-term contracts and, therefore, has tended to be less indicative of the usual supply/demand factors influencing market prices.

Group E

Cross correlations

		1	2	3
1	Bauxite	1.000		
2	Chrome ore	0.873	1.000	
3	Group E	0.950	0.981	1.000
	Group E in real terms	0.808	0.905	1.000
	Group A in real terms	-0.400	-0.540	-0.510
	Group B in real terms	-0.374	-0.471	-0.505
	Group D in real terms	-0.272	-0.338	-0.321

(f) Tungsten ore and aluminium (Group F) also exhibit a high cross correlation (0.57 nominal, 0.47 real) while a joint index is significantly correlated with the steels in nominal terms, and is significant at the 10% level after adjustment for inflation. Tungsten is used in certain steels as a strengthening agent, while aluminium is often a suitable steel substitute. A significant positive correlation between this steel complement and substitute suggests that disturbances in the world steel market predominately reflect changes in demand rather than supply side shocks.

Group F

Cross correlations

		1	2	3
1	Tungsten ore	1.000		
2	Aluminium	0.567	1.000	
3	Group F	0.706	0.982	1.000
	Group F in real terms	0.654	0.972	1.000
	Group C in real terms	0.562	0.318	0.446
	Group D in real terms	0.203	0.295	0.280

(g) In contrast to the metals and ores of Groups E and F, iron ore, manganese ore, ferro-manganese (used as a proxy for iron and steel ferro alloy) and woodpulp prices (Group G) are all negatively correlated with the steels index. They are, however, generally significantly cross correlated with each other. The close association within this group is likely to be related to the obvious link between ferro-manganese and the iron and manganese ores, but it is also interesting to note that all four commodities are major exports of Canada and Scandinavia. Manganese and iron ores are mined together in the form of ferro-manganese in Canada and Norway, while woodpulp is a major export of Canada and Sweden. Iron and manganese ores are complements in steel, with 95% of manganese output used in steel making.

Group G

Cross correlations

	1	2	3	4	5
1 Iron ore	1.000				
2 Manganese ore	0.513	1.000			
3 Iron and steel ferro alloy	0.368	0.526	1.000		
4 Woodpulp	0.672	0.675	0.772	1.000	
5 Group G	0.771	0.680	0.804	0.979	1.000
Group G in real terms	0.549	0.460	0.725	0.957	1.000
Group D in real terms	-0.251	-0.361	-0.149	-0.464	-0.441
Group E in real terms	0.359	0.296	0.392	-0.486	0.348

(h) Group H is formed from the two wool indices. Of these two grades, 64s represent the fine quality merino wool used in knitwear, while 50s is a cross-bred wool produced in New Zealand of a coarser type used in the manufacture of carpets. They are highly correlated with each other (0.89 nominal, 0.87 real) but also have a high correlation with the Group B index (see table opposite). However, although Group B commodities are highly correlated with Group A, the wools show no such association.

Group H

Cross correlations

		1	2	3
1	Wool 64s	1.000		
2	Wool 50s	0.887	1.000	
3	Group H	0.978	0.964	1.000
	Group H in real terms	0.974	0.961	1.000
	Group B in real terms	0.537	0.437	0.506
	Group E in real terms	-0.342	-0.286	-0.329
	Group F in real terms	-0.541	-0.556	-0.567

(j) Out of the remaining nine commodity indices, one more pair stands out, namely the jointly mined lead and zinc ores (Group J). A cross correlation of 0.77 (0.75) produces correlations with their joint index of around 0.9. Elsewhere, however, Group J is only significantly correlated with Groups B and H, although some association with the base metals index (Group A) is apparent in nominal terms.

Group J

Cross correlations

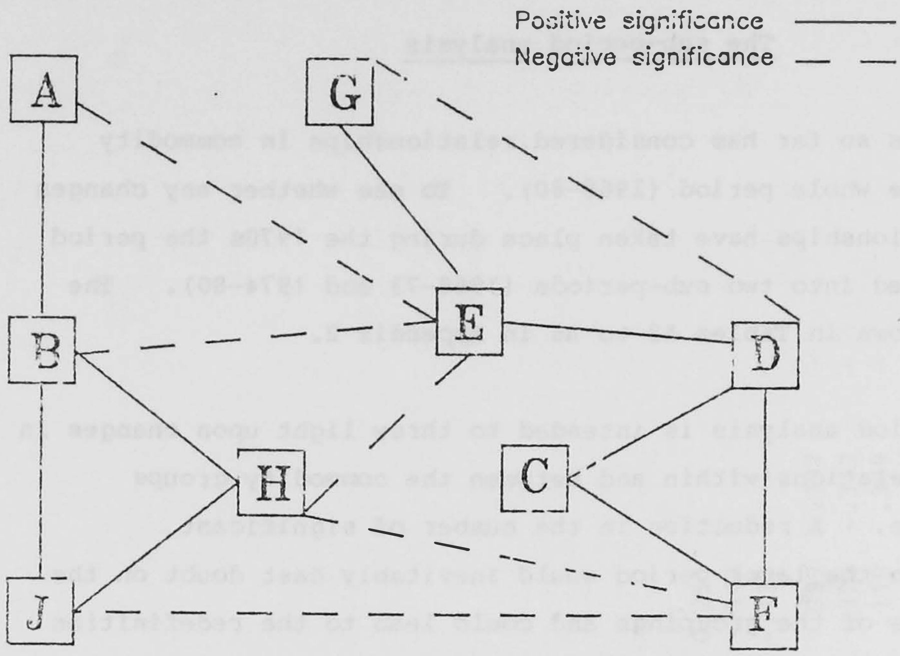
		1	2	3
1	Lead ore	1.000		
2	Zinc ore	0.772	1.000	
3	Group J	0.896	0.973	1.000
	Group J in real terms	0.885	0.972	1.000
	Group B in real terms	0.360	0.282	0.333
	Group F in real terms	-0.573	-0.333	-0.438
	Group H in real terms	0.489	0.198	0.325

(k) In the residual group, we are left with seven commodities: tin ore, tin scrap, nickel and nickel scrap, hides, jute and sugar. There are few significant cross correlations within this group although a number of components exhibit strong correlations with individual commodities in other groups. Tin scrap is significantly correlated with tin and aluminium, possibly reflecting substitutability in consumption. 40%-45% of tin production is used for tin plating, mainly for the canning industry, and this is a market where aluminium is growing rapidly in importance. Nickel is significantly positively correlated with iron ore, while hides are correlated strongly with the wools (Group H) although they do not share the other cross correlations displayed by this Group. Finally, sugar is significantly correlated with woodpulp and jute.

9 The first three examples cited in (k) illustrate that there is nothing unique about any of the grouping arrangements. By starting from a different 'bench mark', or by employing different criteria, we would inevitably have created rather different groups. Hides might easily have been included with the wools, soya beans could have been included with tropical beverages and, as we have seen, a new group could have been formed from tin, tin scrap and aluminium. In general, however, we would not expect alternative groupings to emphasise patterns of association substantially different from those described here.

10 As the diagram indicates (see opposite) the most complex pattern of association is that surrounding Group E. Bauxite and chrome ore are correlated significantly with five other groups accounting for twenty-seven of the remaining thirty-four commodities from which group indices are compiled. Most of these correlations - notably those with Groups A and B - are negative, however, possibly reflecting long lags in the adjustment of these two producer prices to the position in the economic cycle. It is certainly quite striking that the two positive correlations of Group E (Groups D and G) are wholly producer-prices, while the negative associations are with groups wholly or predominantly composed of commodities traded in more structured markets.

Interrelationships between the commodity groups in real terms



A = Base metals

B = Agricultural materials

C = Tropical beverages

D = Iron and Steel

E = Bauxite and chrome ore

F = Aluminium and tungsten ore

G = Iron ore, manganese ore, etc

H = Wools

J = Lead and zinc ores

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11 Setting aside this producer/market-price dichotomy, the key associations appear to surround Groups B and D. These are particularly interesting since, although both groups are linked to four other groups, their only common association is with Group E, where their correlations are of opposite sign. Group B commodities, which are predominantly agricultural raw materials, correlate strongly with the base metals (Group A), the wools (Group H) and certain ores (Groups E and J), while Group D (the steels index) is associated with a number of ores and substitute metals (Groups E, F and G) and with tropical beverages (Group C).

12 The separation of ferrous and ferrous alloying metals from the base metals and base metal ores is very striking; indeed the base metals index (Group A), which was originally established as a bench mark, is shown to have few important correlations beyond its close association with Group B.

3

The sub-period analysis

13 The analysis so far has considered relationships in commodity prices over the whole period (1968-80). To see whether any changes in these relationships have taken place during the 1970s the period has been divided into two sub-periods (1968-73 and 1974-80). The results are shown in Tables A3 to A6 in Appendix 2.

14 The sub-period analysis is intended to throw light upon changes in the cross correlations within and between the commodity groups described above. A reduction in the number of significant correlations in the later period would inevitably cast doubt on the appropriateness of the groupings and could lead to the redefinition of some of the indices. Changing patterns of association between the groups (see Tables A and B), however, may cast light on structural changes directly linking commodity markets.

15 The cross correlations between the base metals are generally lower in the second period, although they still remain positive and significant in nominal terms. In real terms, the cross correlations are significant at the 5% level (except for one which is significant only at the 10% level). Of the seven components, copper, lead, zinc and copper scrap record lower correlations with the aggregate index although most of these changes are very small. The cross correlation between the base metals and other commodities shows no overall tendency to rise or fall, with only lead scrap recording a significant upward bias. The correlations in Group B are also generally lower, although all correlations with the index remain significant. Against this lower tendency, steel scraps' correlation with the Group B index is higher in both nominal and real terms, while aluminium's correlation is higher in real terms only.

16 In contrast to Groups A and B, the cross correlations in the beverage group are generally stronger in the later period, whether measured in nominal or real terms. The correlations of coffee and tea with the joint index are dramatically higher in real terms

Table A

Inter-group correlations - sub-period analysis in nominal terms (a)

		A	B	C	D	E	F	G	H	J
Group A:	1st sub-period	-								
	2nd sub-period	-								
	Whole period	-								
Group B:	1st sub-period	.786	-							
	2nd sub-period	.840	-							
	Whole period	.786	-							
Group C:	1st sub-period	.723	.848	-						
	2nd sub-period	.157	.242	-						
	Whole period	.201	.241	-						
Group D:	1st sub-period	.080	-.075	.124	-					
	2nd sub-period	-.417	-.365	.113	-					
	Whole period	-.250	-.252	.207	-					
Group E:	1st sub-period	-.647	-.661	-.686	.080	-				
	2nd sub-period	-.504	-.418	-.247	.309	-				
	Whole period	-.429	-.354	-.153	.411	-				
Group F:	1st sub-period	.472	.298	.172	.267	.046	-			
	2nd sub-period	-.086	.159	.362	.523	-.010	-			
	Whole period	.057	.076	.389	.617	.209	-			
Group G:	1st sub-period	.695	.863	.720	-.016	-.389	.528	-		
	2nd sub-period	.163	.338	-.153	.254	.528	.436	-		
	Whole period	.288	.422	-.006	.296	.487	.501	-		
Group H:	1st sub-period	.308	.586	.701	-.036	-.618	-.499	0.251	-	
	2nd sub-period	.383	.096	.266	-.483	-.585	-.399	-.548	-	
	Whole period	.298	.493	.151	-.282	-.378	-.450	-.137	-	
Group J:	1st sub-period	.241	.336	.203	.200	-.138	-.168	.039	.397	-
	2nd sub-period	.539	.604	.293	-.075	.114	.007	.370	-.312	-
	Whole period	.358	.438	.121	-.110	-.064	-.188	.119	.309	-

(a) 1st sub-period 1968 I - 1973 IV
2nd sub-period 1974 I - 1980 IV
Whole period 1968 I - 1980 IV

Table B

Inter-group correlations - sub-period analysis in real terms (a)

		A	B	C	D	E	F	G	H	J
Group A:	1st sub-period	-								
	2nd sub-period	-								
	Whole period	-								
Group B:	1st sub-period	.667	-							
	2nd sub-period	.841	-							
	Whole period	.735	-							
Group C:	1st sub-period	.505	.598	-						
	2nd sub-period	.207	.346	-						
	Whole period	.175	.214	-						
Group D:	1st sub-period	-.480	-.833	-.364	-					
	2nd sub-period	-.342	-.365	.414	-					
	Whole period	-.397	-.555	.320	-					
Group E:	1st sub-period	-.705	-.844	-.654	.696	-				
	2nd sub-period	-.517	-.486	-.183	.259	-				
	Whole period	-.510	-.505	-.142	.322	-				
Group F:	1st sub-period	.086	-.264	-.285	.387	.320	-			
	2nd sub-period	-.197	-.001	.581	.195	-.219	-			
	Whole period	-.135	-.250	.446	.270	.047	-			
Group G:	1st sub-period	.506	.788	.423	-.634	-.515	.098	-		
	2nd sub-period	.026	.059	-.271	-.450	.396	-.034	-		
	Whole period	.110	.186	-.169	-.441	.348	.133	-		
Group H:	1st sub-period	.174	.526	.652	-.412	-.592	-.836	.105	-	
	2nd sub-period	.429	.305	.414	.310	-.299	-.056	-.541	-	
	Whole period	.266	.506	.180	-.128	-.329	-.567	-.239	-	
Group J:	1st sub-period	.011	.095	-.263	-.302	-.239	-.547	-.291	.307	-
	2nd sub-period	.492	.555	.383	.080	.147	-.075	.070	.010	-
	Whole period	.249	.333	.110	-.126	-.077	-.438	-.150	.325	-

(a) 1st sub-period 1968 I - 1973 IV
2nd sub-period 1974 I - 1980 IV
Whole period 1968 I - 1980 IV

TABLE C

CORRELATION OF INDIVIDUAL COMMODITIES WITH THE TOTAL INDICES OF GROUPS A-J IN NOMINAL TERMS

	A	B	C	D	E	F	G	H	J
Iron ore	.393	.575	-.054	-.046	.364	.164	.771*	.207	.080
Steel scrap	.717	.629*	.090	-.028	-.258	.152	.450	.125	.246
Bauxite	-.275	-.172	-.021	.466	.950*	.295	.641	-.333	.030
Lead ore	.320	.463	-.003	-.131	-.185	-.274	.066	.489	.896*
Zinc ore	.347	.381	.179	-.079	.009	-.129	.142	.173	.973*
Tin ore	-.056	-.188	.039	.075	.053	-.362	-.315	.194	.151
Manganese ore	.262	.470	.121	.102	.360	.410	.680*	-.126	.474
Chrome ore	-.494	-.444	-.224	.357	.981*	.137	.364	-.382	-.113
Tungsten ore	.103	.136	.566	.487	.162	.706*	.462	-.266	-.141
Copper scrap	.939*	.668	.083	-.258	-.418	-.070	.155	.323	.327
Nickel scrap	.300	.068	.127	.096	-.128	.127	.085	.098	-.111
Aluminium scrap	.745	.543*	.435	-.042	-.376	.155	.082	.223	.130
Lead scrap	.740*	.440	.257	.163	-.305	.187	.149	.169	.323
Zinc scrap	.836*	.801	.074	-.127	-.287	.125	.489	.259	.573
Tin scrap	.152	.077	-.143	.505	-.022	.484	.225	-.158	-.162
Iron and steel - sheets	-.179	-.139	.161	.878*	.398	.623	.430	-.195	-.325
Iron and steel - bars	-.280	-.313	.184	.869*	.338	.452	.092	-.306	.144
Iron and steel - ferro alloys	-.097	.058	.019	.629	.554	.647	.804*	-.316	.058
Copper	.986*	.749	.163	-.300	-.442	.014	.242	.317	.287
Nickel	.018	.008	.003	.042	.288	.197	.489	-.001	-.320
Aluminium	.038	.051	.281	.603	.206	.982*	.471	-.464	-.182
Lead	.762*	.567	.438	.045	-.431	.227	.229	.250	.191
Zinc	.851*	.824	.104	-.259	-.241	.046	.413	.198	.589
Tin	.616*	.530	.468	.220	-.235	.567	.378	-.013	.309
Hide	.088	-.056	-.023	-.133	-.200	-.591	-.445	.502	.241
Soyabeans	.532	.797*	.544	-.152	-.356	.160	.261	.410	.323
Rubber	.810	.842*	.220	-.308	-.400	-.071	.135	.541	.340
Woodpulp	.319	.395	-.001	.280	.441	.494	.979*	-.199	.129
Hardwood	.646	.785*	.091	-.077	-.174	.343	.499	.226	.319
Lumber	.662	.810*	.318	-.247	-.539	-.156	.031	.700	.555
Cotton	.707	.761*	.254	-.394	-.275	-.077	.177	.312	.479
Wool 64s	.305	.528	.099	-.273	-.361	-.395	-.073	.978*	.277
Wool 50s	.271	.419	.206	-.280	-.374	-.491	-.210	.964*	.331
Jute	-.250	-.119	-.098	.601	.156	.524	.221	-.377	.327
Sisal	.705	.824*	.252	-.068	-.317	.201	.504	.439	.550
Lard	.593	.761*	.179	-.007	-.120	.242	.447	.165	.281
Soya oil	.622	.826*	.339	-.002	-.218	.380	.497	.090	.337
Coffee	.111	.056	.854*	.051	-.090	.105	-.153	.147	.001
Cocoa	.377	.475	.859*	.083	-.326	.237	-.020	.373	.258
Sugar	.053	.192	-.157	.046	.077	.372	.566	-.114	.062
Tea	.034	.111	.862*	.335	.023	.598	.138	-.079	.019
Wheat	.709	.920*	-.060	-.253	-.204	-.007	.522	.432	.405
Maize	.644	.916*	.248	-.245	-.258	.094	.460	.470	.290

* Commodity is a component of the grouping.

(0.40 to 0.89 and -0.03 to 0.89) and cocoa's correlation changes from 0.71 to 0.96. The significant positive correlation of coffee and cocoa in the second period can perhaps be explained by increased substitution in production as growers have become more aware of price divergences. However, all three markets have suffered supply problems during the later period which have caused their prices to rise.

17 In the second period the correlation of the steels of Group D with each other is dramatically higher, especially in nominal terms, where it rose from -0.24 to 0.71 and, as a result, their correlations with the combined index are higher (steel sheets from 0.73 to 0.87 and steel bars from 0.83 to 0.96 in real terms). This perhaps reflects the change in the pattern of international trade in steel products during 1977 when Japanese penetration, at what was regarded as unrealistically low prices, of European, Canadian, and to some extend US, markets had damaging effects on already depressed domestic markets. The correlations of bauxite and chrome ore between themselves and with their joint index (Group E) are higher in the second period in both nominal and real terms. The cross correlation in nominal terms shows a substantial increase (from 0.28 to 0.88). The correlations of Group F (tungsten ore and aluminium) with each other and their combined index, whether in nominal or real terms, are noticeably higher though not as dramatic as Group E.

18 In Group G, manganese ore, ferro-manganese and woodpulp correlations amongst themselves, and combined, are higher in the second period. The cross correlations of iron ore and the rest of the group are higher, excepting woodpulp which is lower, but the latter still remains significant and positive in both nominal and real terms at the 5% level. The correlation of the wools, grades 50s and 64s, with each other is slightly lower in the second period in real terms (0.90 to 0.82) and their correlations with the index are slightly lower. The two ores of Group J (lead and zinc) have a closer association in the second period with higher positive correlations between each other and their index in both nominal and real terms, e.g. their cross correlation rises from 0.80 to 0.88 in real terms.

19 In the residual category, out of a possible twenty-one cross correlations, five have risen and sixteen have fallen in real terms between the two periods. On closer examination of the correlation of the seven commodities with Groups A-J between the sub-periods, there seems to be no justification for including any of these in the original groupings. Where significant correlations occur with the aggregate indices, it is generally found that the other cross correlations that characterise these indices are not exhibited by the proposed new entrant.

20 The sub-period analysis shows some relationships breaking down and new ones emerging. In the second period, both Group H (wools) and Group J (lead and zinc ores) have become significantly associated with the base metals and tropical beverages. The correlations between the wools and tropical beverages are particularly interesting since a high degree of association exists in both sub-periods despite an insignificant correlation in the full period. This suggests that the full period result may have been distorted by a structural change in the nature of the association between the groups. In contrast, the correlation of the steels index (Group D) with Groups E and F breaks down in the later period as does the negative association between Group F and the lead and zinc ores. Perhaps the most striking result however is that for Group F (tungsten ore and aluminium) and the wools: a significant negative association in the earlier period changes to positive in the later period.

21 In summary, the most important changes are probably the weaker association of the steels index with Groups E and F and the changed relationships surrounding the wools index.

22 If the structure of commodity markets does not change over time, we would expect roughly half the correlation coefficients to be higher and half to be lower (for negative correlations, lower is taken to mean more negative). To test whether the observed results are consistent with this expectation, or whether they display an upward or downward bias, the 95% confidence interval of the binomial distribution is calculated as $np \pm 1.96 \times \sqrt{[np(1-p)]}$ where n is the number of correlations and p is the proportion expected to rise (fall). With 903 cross correlations and a prior expectation that

half of them will rise and half fall, the expected range of higher and lower correlations is 422 to 481.[1] Out of the total correlations tested, 594 are lower in the second period in nominal terms. This is significantly different from one half at the 95% level. In real terms however, the balance of higher and lower correlations (477 up and 426 down) shows no significant bias.

23 The contrast between the nominal and real results is both interesting and intriguing. A number of explanations may be offered to rationalise the lower nominal cross correlations in the later period, although taken separately they leave the associated insignificant change in real correlations unresolved. For example, if demand fluctuations have a similar influence on all commodities whilst supply shocks are commodity-specific, then the results suggest that the movement of commodity prices in the late 1970s was influenced by supply considerations, rather than by fluctuations in demand, to a greater extent than in the earlier period.

24 Anecdotal evidence indicates crop failures, transportation problems, cuts in production to conserve resources, and industrial stoppages as possible explanations. For example, Zambia, being a landlocked country relying on neighbouring countries to supply rail routes to transport copper to the ports, has always suffered from transportation problems. However, in the 1970s the culmination of the Angolan war (which had a disruptive effect on the 'Benguela Railway'), the devastation of the Southern Route by the Zimbabwe guerrillas, and the deterioration of the Tazara Railway rolling stock (because no funds were available to replace or repair breakdowns) caused an uneven supply of exports. This was particularly relevant in 1978/9 when Zambian exports were drastically reduced as a direct result of the war in Zimbabwe. Consequently, copper had to be stockpiled at the mines. This disruption to the flow of copper exports caused a world shortage and the LME settlement price rose to a peak of £1,056 per tonne during March 1979. Cocoa prices rose dramatically in the late 1970s as Ghanaian production fell: poor returns to the farmer

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[1] This statistic holds exactly only if each of the changes in correlation were entirely independent. Since this is probably not the case, the test can only be regarded as indicative.

discouraged new plantings of cocoa and self-sufficiency in other basic foodstuffs became preferable. The current situation of excess supply is a result of diversification from less profitable crops into cocoa, by other countries, particularly Brazil, when prices were high. Indonesian exports of hardwood have fallen dramatically in the past three years as the government has attempted to use quota restrictions to force domestic producers to invest in timber processing plant to raise the value added per unit exported.

25 The increasing sophistication of commodity markets may have also contributed to changes in the behaviour of commodity prices. Rational expectations theory asserts that markets at each time incorporate all information available at that time, including all information about the future. Thus any change in commodity prices will reflect just the receipt of new information during that period. Then, if developments in demand are largely anticipated they will have no influence on commodity prices: if supply changes are not anticipated they will account for the entire commodity price movement. If this is the case, and if supply shocks relate more to individual commodities, then a shift towards less positive correlation between individual commodity prices might be expected. Thus the observed lower nominal correlations are consistent with a more prevalent use of rational expectations in the late 1970s than in the earlier period.

26 In general, the more that commodities are substitutes for each other the more their prices will tend to move together. When they are complements, however, the relationship between price changes is not so clear.[1] Thus the shift towards less positive correlation between commodity price movements might be explained in terms of reduced substitutability with other commodities, as technological processes become more commodity-specific. Additionally, commodities may increasingly be used together to create a finished product: for instance chrome and manganese are essential inputs, with iron ore, in the production of steel. Reduced substitutability and increased complementarity provide a third possible explanation for the observed changes between periods.

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[1] See Appendix 1.

27 The failure of real correlations to exhibit a similar downward bias may be explained, in part, by lack of information about world prices and, in part, by each market using their own different indicators of world inflation. Traders and speculators are probably more responsive to nominal price changes than to changes in real values and may, in the short term at least, be unaware of the implications for the latter caused by changes in the former. The disaggregate analysis of the binomial test casts some further light on this result. Most of the commodities exhibiting a significant number of higher real correlations in the second sub-period are metal ores and ferrous products and this may suggest a greater awareness amongst producers of their economic links with the metal markets which have exhibited large fluctuations in real values since the 1975 recession.

The impact of exchange rate fluctuations

28 So far, we have confined our attention to the movement of prices expressed in US dollars. However, for most commodities produced and consumed throughout the world the choice of the dollar is no more than a convenience derived from the importance of the United States in world trade and the relative stability of the dollar as an international store of value. In the same way, however, that the sterling prices of commodities traded in London markets will vary in response to changes in sterling's international value it can be demonstrated [1] that dollar prices exhibit similar properties. If the correlations described above reflect no more than the common adjustment to exchange rate fluctuations then they are of small concern. In practice, our adjustments to compensate for exchange rate movements result in few significant changes although they do, once again, draw attention to the importance of the market/producer-price distinction in the analysis of commodity markets.

29 In order to investigate this possibility, the commodity indices were re-compiled in terms of SDRs which were taken as a more stable measure of value than any individual currency, including the dollar. As anticipated, many of the new cross correlations are lower, indeed for the base metals and Group B the fall is universal. Few of these changes are large, however, and only a small number of previously significant correlations are lost. In many of the later groups, though, the results are more mixed with a good scattering of higher correlations. The general picture which emerges can perhaps best be summarised with reference to the market/producer-price dichotomy. In the freely traded markets, best typified by Group A and the majority of Group B commodities, dollar prices vary inversely with the dollar's international value so that the change to SDR indices leads to lower cross correlations. For a number of other commodities whose prices are fixed by contract in US dollars, the conversion into SDRs inevitably results in more volatile indices, sharing the common feature of the SDR/dollar exchange rate and hence higher cross correlations.

[1] Wright (1981).

30 The main exceptions to this pattern are amongst the tropical beverages which, despite being freely traded, exhibit higher cross correlations when expressed in SDRs. This may reflect the impact of the international coffee and cocoa organisations which in recent years have attempted to influence market prices when they diverge from an agreed target or range set in US dollars. Thus, a commodity market which is backed by an effective buffer stock or other price support programme may take on the appearance of a producer, rather than market-prices, regime.

Summary and conclusion

31 This paper has used a simple statistical technique to group commodity prices into nine aggregate indices, each based on the relationship between commodity prices within the category and the prices of commodities in other aggregates. Prices of the four base metals (copper, lead, tin and zinc) clearly move closely together. Prices of a group of foods and agricultural non-foods move closely together and with the base metals' prices and these commodities form a second group. It is interesting that prices of the steels do not move closely with those of the base metals, possibly because they are set at producer rather than market prices, but they often move with the metals which are associated with the new technological industries (aluminium, bauxite, chrome and tungsten ores) and these commodities can be put together into two groupings. Wools and beverages are two additional categories and the remaining categories contain small numbers of commodities.

32 This suggests that the conventional commodity aggregates may not be the most appropriate for explaining and forecasting commodity prices. It suggests the need to formulate a new test to compare directly these new commodity groups with our existing price aggregates [1] as explanatory variables in the balance of payments forecasts.

33 The results reported in this paper raise a number of questions which require further careful exploration: the most appropriate price numeraire for the analysis of commodity markets (dollar or a broader basket of currencies); the relationship between market and producer prices, i.e. the extent to which markets lead or lag producer price regimes; and the reason for the interesting sub-period analysis result which indicates that cross correlations tend to be less postive in nominal terms but show no significant change in response in real terms between the two periods.

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[1] Metal ores, metals, agricultural non-foods and foods.

Appendix 1

Complements or substitutes

34 Commodities can be complements for each other in consumption (sugar and tea) or production (zinc is mined with lead). Similarly, they can be substitutes in consumption (wheat and barley) or production (farmers can plant coffee or cocoa bushes; limited transport can be used to move copper or chrome). The effect of the price movements of one commodity on another depends upon which of these relationships holds between the two commodities concerned.

35 The table below shows the effects on the price of a commodity of 'micro-shocks' to the demand or supply of another commodity. A 'micro-shock' is defined to be a shock that affects only one commodity and does not itself affect the other.

	Substitutes in:		Complements in:	
	Commodity consumption	Commodity production	Commodity consumption	Commodity production
Demand	+	+	+	-
Supply	+	- (a)	-	+

(a) The relationship is negative if only one commodity is affected by the initial supply-side shock. However, supply shocks are more likely to hit both commodities (e.g. frosts in Brazil hit both coffee and cocoa bushes). In that case, the relationship is positive.

36 'Macro-shocks' will affect all commodities, although probably not equally. A rise in industrial activity is an obvious example. The paper assumes that demand-side shocks are more likely to be macro-shocks whilst supply-side shocks are unlikely to affect all commodities and so are more likely to be micro-shocks.

Appendix 2

Correlations of changes in price indices

TABLE A1

CORRELATION OF CHANGES IN NOMINAL PRICE INDICES ON A YEAR EARLIER (PERCENTAGE) 1968 I - 1980 IV

	1	2	3	4	5	6	7	8	9	10	11	12	13
1 Iron ore	1.000												
2 Steel scrap	0.263	1.000											
3 Copper ore	0.313	0.625	1.000										
4 Nickel "	-0.054	0.260	0.358	1.000									
5 Bauxite	0.463	-0.113	-0.312	-0.076	1.000								
6 Lead ore	0.098	0.211	0.318	-0.053	-0.099	1.000							
7 Zinc "	0.057	0.264	0.302	-0.120	0.103	0.772	1.000						
8 Tin "	-0.163	-0.115	0.155	-0.017	-0.019	0.134	0.156	1.000					
9 Manganese ore	0.513	0.387	0.102	-0.223	0.425	0.329	0.513	-0.182	1.000				
10 Chrome "	0.288	-0.333	-0.452	-0.156	0.873	-0.224	-0.042	0.103	0.298	1.000			
11 Tungsten "	0.080	0.453	-0.044	0.209	0.274	-0.238	-0.058	-0.194	0.361	0.080	1.000		
12 Copper scrap	0.313	0.625	1.000	0.358	-0.312	0.318	0.302	0.155	0.102	-0.452	-0.044	1.000	
13 Nickel "	-0.050	0.263	0.354	0.999	-0.077	-0.063	-0.128	-0.029	-0.220	-0.153	0.215	0.354	1.000
14 Aluminium "	0.141	0.620	0.750	0.304	-0.285	-0.036	0.205	0.202	0.112	-0.404	0.315	0.750	0.310
15 Manganese "	0.513	0.387	0.102	-0.223	0.425	0.329	0.513	-0.182	1.000	0.298	0.361	0.102	-0.220
16 Lead "	0.069	0.590	0.786	0.434	-0.170	0.270	0.329	0.282	0.097	-0.365	0.161	0.786	0.426
17 Zinc "	0.447	0.768	0.747	0.041	-0.103	0.515	0.560	-0.107	0.506	-0.381	0.124	0.747	0.038
18 Tin "	0.055	0.269	0.135	0.063	0.006	-0.175	-0.143	-0.157	0.132	-0.040	0.134	0.135	0.065
19 Ir & st sheets	0.156	0.070	-0.200	0.231	0.477	-0.264	-0.322	0.027	0.059	0.325	0.547	-0.200	0.225
20 Ir & st bars	-0.243	-0.141	-0.275	-0.057	0.352	0.044	0.194	0.090	0 127	0.317	0.292	-0.275	-0.066
21 I & s fe alloys	0.368	0.179	-0.225	0.114	0.672	0.015	0.079	-0.349	0.526	0.445	0.522	-0.225	0.115
22 Copper	0.389	0.667	0.949	0.342	-0.312	0.274	0.267	-0.029	0.200	-0.493	0.060	0.949	0.342
23 Nickel	0.452	-0.055	-0.000	0.269	0.349	-0.249	-0.328	-0.128	0.016	0.234	0.196	-0.000	0.274
24 Aluminium	0.166	0.079	-0.072	0.085	0.275	-0.257	-0.133	-0.377	0.393	0.145	0.567	-0.072	0.036
25 Lead	0.174	0.578	0.658	0.334	-0.217	0.128	0.211	-0.101	0.024	-0.532	0.249	0.658	0.334
26 Zinc	0.466	0.706	0.765	0.005	-0.100	0.510	0.586	-0.077	0.564	-0.309	0.086	0.765	0.002
27 Tin	0.146	0.715	0.466	0.150	-0.095	0.160	0.373	-0.185	0.510	-0.309	0.592	0.466	0.150
28 Hide	-0.243	-0.053	0.263	0.103	-0.221	0.275	0.201	0.639	-0.442	-0.163	-0.463	0.763	0.094
29 Soya beans	0.333	0.445	0.374	0.009	-0.151	0.376	0.265	-0.235	0.323	-0.464	0.257	0.374	0. 10
30 Rubber	0.439	0.486	0.606	0.158	-0.304	0.311	0.311	0.050	0.200	-0.431	-0.035	0.806	0.161
31 Wood pulp	0.672	0.541	0.192	0.118	0.597	0.049	0.169	-0.291	0.675	0.318	0.524	0.192	0.123
32 Hard wood	0.610	0.395	0.584	0.085	-0.049	0.381	0.249	-0.193	0.522	-0.242	0.102	0.584	0.092
33 Lumber	0.275	0.349	0.622	0.028	-0.376	0.611	0.467	0.060	0.130	-0.603	-0.140	0.622	0.023
34 Cotton	0.431	0.412	0.663	-0.134	-0.186	0.449	0.451	0.144	0.445	-0.310	-0.035	0.663	-0.136
35 Wool 64s	0.268	0.140	0.302	0.100	-0.309	0.476	0.132	0.054	-0.033	-0.371	-0.244	0.302	0.096
36 Wool 50s	0.118	0.101	0.331	0.095	-0.344	0.471	0.219	0.351	-0.168	-0.367	-0.272	0.331	0.090
37 Jute	-0.174	-0.009	-0.277	-0.043	0.205	0.152	0.104	-0.257	0.200	0.108	0.238	-0.277	-0.053
38 Sisal	0.414	0.691	0.571	0.145	-0.119	0.509	0.522	-0.192	0.504	-0.422	0.262	0.571	0.144
39 Lard	0.424	0.573	0.483	0.326	0.059	0.304	0.247	-0.396	0.364	-0.220	0.269	0.483	0.328
40 Soya oil	0.408	0.677	0.440	0.085	-0.020	0.320	0.325	-0.407	0.575	-0.328	0.427	0.440	0.088
41 Coffee	-0.035	-0.039	0.074	0.099	-0.030	-0.109	0.069	0.282	-0.046	-0.117	0.413	0.074	0.101
42 Cocoa	0.040	0.203	0.263	0.140	-0.174	0.139	0.289	0.013	0.089	-0.400	0.411	0.263	0.141
43 Sugar	0.276	0.308	0.027	0.176	0.138	0.104	0.032	-0.247	0.438	0.018	0.290	0.027	0.174
44 Tea	-0.051	0.062	-0.099	0.087	0.148	-0.059	0.067	-0.140	0.241	-0.057	0.629	-0.099	0.087
45 Wheat	0.680	0.630	0.605	-0.061	-0.060	0.445	0.344	-0.163	0.535	-0.280	-0.010	0.605	-0.059
46 Maize	0.592	0.763	0.516	0.099	-0.101	0.318	0.247	-0.214	0.465	-0.339	0.261	0.516	0.106
47 Metal ores (UK)	0.241	0.426	0.582	0.899	0.066	0.053	0.032	0.140	0.012	-0.050	0.236	0.582	0.898
48 Metals (UK)	0.361	0.724	0.889	0.340	-0.207	0.282	0.330	-0.088	0.321	-0.438	0.255	0.889	0.337
49 Ag Non Foods	0.525	0.561	0.677	0.131	-0.204	0.538	0.381	-0.117	0.336	-0.475	0.062	0.677	0.130
50 Foods	0.495	0.427	0.311	0.034	0.109	0.395	0.257	-0.355	0.598	-0.082	0.173	0.311	0.031

	14	15	16	17	18	19	20	21	22	23	24	25
14 Aluminium "	1.000											
15 Manganese "	0.112	1.000										
16 Lead "	0.743	0.097	1.000									
17 Zinc "	0.570	0.506	0.666	1.000								
18 Tin "	0.229	0.132	0.407	0.244	1.000							
19 Ir & st sheets	-0.025	0.059	0.143	-0.128	0.451	1.000						
20 Ir & st bars	-0.075	0.127	0.122	-0.108	0.419	0.528	1.000					
21 I & s fe alloys	-0.196	0.526	-0.006	0.146	0.321	0.642	0.475	1.000				
22 Copper	0.745	0.200	0.715	0.773	0.114	-0.206	-0.341	-0.153	1.000			
23 Nickel	-0.044	0.016	-0.009	-0.025	-0.035	0.239	-0.160	0.326	0.073	1.000		
24 Aluminium	0.100	0.393	0.177	0.124	0.556	0.590	0.464	0.630	-0.003	0.167	1.000	
25 Lead	0.658	0.024	0.753	0.661	0.318	0.078	-0.022	0.034	0.697	0.090	0.193	1.000
26 Zinc	0.534	0.564	0.528	0.885	0.044	-0.239	-0.228	0.037	0.787	-0.168	0.034	0.536
27 Tin	0.635	0.510	0.591	0.679	0.443	0.176	0.185	0.244	0.532	-0.121	0.516	0.659
28 Hide	0.156	-0.442	0.306	0.015	-0.095	-0.227	-0.013	-0.475	0.082	-0.227	-0.575	0.234
29 Soya beans	0.348	0.326	0.285	0.542	-0.105	-0.052	-0.222	0.095	0.480	-0.090	0.107	0.524
30 Rubber	0.754	0.200	0.564	0.669	0.065	-0.238	-0.318	-0.237	0.613	-0.077	-0.060	0.553
31 Wood pulp	0.142	0.675	0.208	0.528	0.215	0.398	0.095	0.772	0.265	0.470	0.449	0.268
32 Hard wood	0.364	0.522	0.400	0.664	0.209	0.036	-0.175	0.225	0.628	0.161	0.370	0.364
33 Lumber	0.505	0.130	0.489	0.667	-0.022	-0.252	-0.189	-0.211	0.636	-0.150	-0.155	0.552
34 Cotton	0.522	0.445	0.403	0.638	-0.212	-0.348	-0.349	-0.202	0.701	-0.132	-0.090	0.338
35 Wool 64s	0.176	-0.083	0.121	0.280	-0.121	-0.162	-0.324	-0.256	0.379	0.026	-0.404	0.216
36 Wool 50s	0.274	-0.167	0.215	0.218	-0.201	-0.231	-0.267	-0.377	0.291	-0.035	-0.513	0.271
37 Jute	-0.291	0.200	0.009	0.021	0.363	0.452	0.618	0.610	-0.313	-0.290	0.565	-0.095
38 Sisal	0.518	0.504	0.525	0.853	0.200	-0.021	-0.104	0.252	0.620	0.110	0.171	0.635
39 Lard	0.337	0.364	0.349	0.562	0.159	0.063	-0.082	0.300	0.540	-0.044	0.215	0.472
40 Soya oil	0.406	0.575	0.337	0.682	0.166	0.046	-0.060	0.314	0.555	-0.094	0.335	0.465
41 Coffee	0.416	-0.046	0.199	-0.096	-0.291	0.039	0.034	-0.137	0.116	0.177	-0.010	0.281
42 Cocoa	0.557	0.089	0.320	0.256	-0.131	0.064	0.064	-0.062	0.337	-0.187	0.145	0.519
43 Sugar	-0.068	0.438	0.020	0.279	0.166	0.176	-0.090	0.503	0.060	0.305	0.369	-0.064
44 Tea	0.170	0.241	0.121	0.015	-0.011	0.291	0.285	0.245	-0.018	0.069	0.514	0.298
45 Wheat	0.403	0.535	0.365	0.804	0.195	-0.117	-0.335	0.140	0.672	0.026	0.002	0.441
46 Maize	0.456	0.465	0.264	0.642	0.011	-0.087	-0.353	0.078	0.615	0.179	0.036	0.455
47 Metal ores (UK)	0.497	0.012	0.607	0.285	0.136	0.272	-0.073	0.160	0.543	0.275	0.108	0.419
48 Metals (UK)	0.753	0.321	0.790	0.825	0.291	-0.010	-0.064	0.036	0.940	0.046	0.241	0.778
49 Ag Non Foods	0.533	0.336	0.483	0.765	0.020	-0.130	-0.275	0.017	0.735	0.017	-0.024	0.601
50 Foods	0.139	0.598	0.311	0.611	0.551	0.247	0.179	0.491	0.351	0.013	0.524	0.331

TABLE A1 (continued)

CORRELATION OF CHANGES IN NOMINAL PRICE INDICES ON A YEAR EARLIER (PERCENTAGE) 1968 I - 1980 IV

	26	27	28	29	30	31	32	33	34	35	36	37
1 Iron ore												
2 Steel scrap												
3 Copper ore												
4 Nickel "												
5 Bauxite												
6 Lead ore												
7 Zinc "												
8 Tin "												
9 Manganese ore												
10 Chrome "												
11 Tungsten "												
12 Copper scrap												
13 Nickel "												
14 Aluminium "												
15 Manganese "												
16 Lead "												
17 Zinc "												
18 Tin "												
19 Ir & st sheets												
20 Ir & st bars												
21 I & s fe alloys												
22 Copper												
23 Nickel												
24 Aluminium												
25 Lead												
26 Zinc	1.000											
27 Tin	0.621	1.000										
28 Hide	-0.026	-0.189	1.000									
29 Soya beans	0.571	0.418	-0.055	1.000								
30 Rubber	0.718	0.420	0.177	0.547	1.000							
31 Wood pulp	0.439	0.446	-0.431	0.227	0.109	1.000						
32 Hard wood	0.717	0.460	-0.287	0.529	0.659	0.443	1.000					
33 Lumber	0.627	0.334	0.287	0.697	0.794	-0.008	0.633	1.000				
34 Cotton	0.790	0.326	0.039	0.654	0.750	0.161	0.675	0.703	1.000			
35 Wool 64s	0.202	-0.013	0.369	0.428	0.536	-0.145	0.264	0.680	0.290	1.000		
36 Wool 50s	0.184	-0.010	0.638	0.357	0.520	-0.253	0.162	0.680	0.323	0.887	1.000	
37 Jute	-0.067	0.154	-0.252	0.010	-0.282	0.207	0.081	-0.149	-0.267	-0.339	-0.405	1.000
38 Sisal	0.748	0.700	-0.066	0.607	0.623	0.522	0.673	0.693	0.514	0.456	0.393	0.000
39 Lard	0.629	0.458	-0.156	0.658	0.585	0.420	0.586	0.465	0.407	0.224	0.080	0.193
40 Soya oil	0.730	0.653	-0.339	0.800	0.543	0.496	0.656	0.512	0.583	0.150	0.008	0.180
41 Coffee	-0.045	0.193	0.095	0.297	0.148	-0.132	-0.079	0.182	0.236	0.065	0.243	-0.404
42 Cocoa	0.291	0.492	0.030	0.616	0.523	-0.033	0.228	0.578	0.378	0.352	0.403	-0.062
43 Sugar	0.147	0.29[illegible]	-0.444	0.061	-0.062	0.597	0.328	-0.090	-0.046	-0.060	-0.173	0.514
44 Tea	0.014	0.476	-0.218	0.483	-0.067	0.147	0.079	0.061	0.055	-0.088	-0.066	0.112
45 Wheat	0.805	0.431	-0.054	0.621	0.746	0.481	0.733	0.661	0.682	0.479	0.347	-0.092
46 Maize	0.672	0.469	-0.143	0.690	0.716	0.444	0.668	0.638	0.587	0.521	0.382	-0.223
47 Metal ores(UK)	0.259	0.289	0.153	0.095	0.411	0.302	0.299	0.185	0.120	0.206	0.201	-0.116
48 Metals (UK)	0.800	0.741	-0.006	0.481	0.727	0.383	0.652	0.586	0.608	0.215	0.172	-0.122
49 Ag Non Foods	0.746	0.453	0.106	0.817	0.847	0.303	0.739	0.898	0.742	0.672	0.596	-0.134
50 Foods	0.55[illegible]	0.560	-0.270	0.432	0.397	0.512	0.767	0.417	0.285	0.235	0.051	0.411

	38	39	40	41	42	43	44	45	46	47	48	49	50
38 Sisal	1.000												
39 Lard	0.567	1.000											
40 Soya oil	0.694	0.868	1.000										
41 Coffee	0.030	-0.103	0.035	1.000									
42 Cocoa	0.426	0.355	[illegible]	0.621	1.000								
43 Sugar	0.406	0.182	0.272	-0.314	-0.139	1.000							
44 Tea	0.178	0.206	0.388	0.623	0.585	0.039	1.000						
45 Wheat	0.768	0.675	0.726	-0.195	0.196	0.266	-0.133	1.000					
46 Maize	0.751	0.683	0.727	0.117	0.427	0.257	0.144	0.821	1.000				
47 Metal ores(UK)	0.317	0.435	0.214	0.107	0.207	0.202	0.053	0.213	0.283	1.000			
48 Metals (UK)	0.714	0.582	0.639	0.144	0.403	0.118	0.171	0.631	0.586	0.548	1.000		
49 Ag Non Foods	0.808	0.695	0.729	0.115	0.533	0.117	0.127	0.847	0.631	0.336	0.694	1.000	
50 Foods	0.647	0.656	0.674	-0.339	0.082	0.393	0.149	0.681	0.568	0.202	0.500	0.[illegible]83	1.000

TABLE A2

CORRELATION OF CHANGES IN REAL PRICE INDICES ON A YEAR EARLIER (PERCENTAGE) 1968 I - 1980 IV

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1 Iron ore	1.000																								
2 Steel scrap	0.019	1.000																							
3 Copper ore	0.210	0.578	1.000																						
4 Nickel "	-0.128	0.264	0.397	1.000																					
5 Bauxite	0.406	-0.310	-0.372	-0.138	1.000																				
6 Lead ore	-0.077	0.080	0.235	-0.074	-0.186	1.000																			
7 Zinc "	-0.058	0.109	0.239	-0.127	0.068	0.754	1.000																		
8 Tin "	0.029	-0.066	0.248	0.026	0.115	0.197	0.269	1.000																	
9 Manganese ore	0.274	0.160	-0.075	-0.365	0.303	0.199	0.437	-0.067	1.000																
10 Chrome "	0.323	-0.443	-0.431	-0.176	0.887	-0.237	-0.013	0.224	0.277	1.000															
11 Tungsten "	-0.127	0.384	-0.086	0.183	0.127	-0.375	-0.184	-0.119	0.186	-0.018	1.000														
12 Copper scrap	0.210	0.578	1.000	0.397	-0.372	0.235	0.239	0.248	-0.075	-0.431	-0.085	1.000													
13 Nickel "	-0.121	0.268	0.393	0.999	-0.138	-0.091	-0.134	0.016	-0.360	-0.173	0.190	0.395	1.000												
14 Aluminium "	0.068	0.557	0.736	0.329	-0.311	-0.113	0.164	0.323	-0.015	-0.353	0.313	0.736	0.335	1.000											
15 Manganese "	0.274	0.160	-0.075	-0.365	0.303	0.199	0.437	-0.067	1.000	0.277	0.186	-0.075	-0.360	-0.015	1.000										
16 Lead "	-0.161	0.516	0.772	0.445	-0.296	0.177	0.243	0.349	-0.126	-0.406	0.103	0.772	0.437	0.725	-0.126	1.000									
17 Zinc "	0.190	0.691	0.680	-0.014	-0.312	0.417	0.445	-0.089	0.305	-0.512	-0.029	0.680	-0.017	0.467	0.305	0.584	1.000								
18 Tin "	-0.320	0.092	0.029	-0.003	-0.242	-0.376	-0.321	-0.113	-0.204	-0.172	-0.039	0.029	0.000	0.155	-0.204	0.302	0.044	1.000							
19 Ir & st sheets	-0.082	-0.216	-0.254	0.213	0.313	-0.450	-0.412	0.359	-0.419	0.290	0.387	-0.254	0.209	0.035	-0.419	-0.013	-0.565	0.070	1.000						
20 Ir & st bars	-0.319	-0.419	-0.226	-0.056	0.193	-0.022	0.224	0.451	-0.230	0.308	0.017	-0.226	-0.060	0.029	-0.230	-0.071	-0.476	-0.051	0.482	1.000					
21 I & s fe alloys	-0.020	-0.038	-0.451	0.006	0.501	-0.194	-0.121	-0.415	0.277	0.307	0.374	-0.451	0.007	-0.394	0.277	-0.233	-0.082	0.032	0.068	-0.250	1.000				
22 Copper	0.275	0.623	0.938	0.375	-0.401	0.171	0.179	0.048	0.019	-0.504	0.014	0.938	0.376	0.715	0.019	0.684	0.709	-0.018	-0.303	-0.330	-0.376	1.000			
23 Nickel	0.476	-0.153	0.024	0.247	0.312	-0.260	-0.274	0.086	-0.128	0.256	0.106	0.024	0.252	0.017	-0.128	-0.079	-0.188	-0.225	0.323	0.115	0.058	0.077	1.000		
24 Aluminium	-0.232	-0.273	-0.247	0.018	0.040	-0.569	-0.342	-0.268	0.029	0.037	0.465	-0.247	0.020	0.040	0.029	-0.026	-0.260	0.297	0.304	0.147	0.263	-0.182	0.030	1.000	
25 Lead	-0.024	0.506	0.607	0.338	-0.359	0.025	0.113	-0.060	-0.229	-0.603	0.200	0.607	0.338	0.610	-0.229	0.702	0.582	0.206	-0.071	-0.168	-0.160	0.655	0.030	0.023	1.000
26 Zinc	0.263	0.644	0.691	-0.030	-0.253	0.415	0.475	-0.067	0.441	-0.391	-0.020	0.691	-0.032	0.432	0.441	0.442	0.864	-0.140	-0.601	-0.500	-0.143	0.715	-0.200	-0.256	0.449
27 Tin	-0.211	0.614	0.386	0.132	-0.351	-0.007	0.232	-0.122	0.266	-0.467	0.542	0.388	0.133	0.602	0.266	0.517	0.549	0.277	-0.155	-0.169	-0.051	0.457	-0.269	0.307	0.621
28 Hide	-0.066	-0.019	0.322	0.148	-0.074	0.346	0.319	0.686	-0.371	-0.009	-0.387	0.322	0.141	0.242	-0.371	0.334	0.019	-0.063	0.099	0.394	-0.535	0.126	0.010	-0.402	0.248
29 Soya beans	0.142	0.329	0.263	-0.023	-0.302	0.280	0.176	-0.165	0.146	-0.533	0.191	0.263	-0.021	0.278	0.146	0.155	0.407	-0.304	-0.262	-0.317	-0.158	0.383	-0.129	-0.155	0.458
30 Rubber	0.346	0.417	0.783	0.180	-0.373	0.217	0.258	0.153	0.050	-0.412	-0.077	0.783	0.183	0.753	0.050	0.531	0.593	-0.054	-0.320	-0.262	-0.479	0.773	-0.044	-0.262	0.502
31 Wood pulp	0.356	0.421	0.050	0.013	0.384	-0.127	-0.033	-0.335	0.434	0.145	0.387	0.050	0.017	-0.007	0.434	0.071	0.435	0.011	-0.165	-0.574	0.739	0.127	0.125	0.071	0.121
32 Hard wood	0.365	0.201	0.529	0.039	-0.330	0.242	0.105	-0.109	0.272	-0.399	-0.090	0.529	0.037	0.303	0.272	0.266	0.527	-0.109	-0.448	-0.538	-0.176	0.568	0.044	0.033	0.225
33 Lumber	0.143	0.193	0.550	0.027	-0.466	0.553	0.456	0.227	-0.091	-0.575	-0.243	0.550	0.023	0.481	-0.091	0.380	0.508	-0.255	-0.306	-0.029	-0.578	0.550	-0.065	-0.359	0.468
34 Cotton	0.369	0.317	0.602	-0.148	-0.213	0.379	0.418	0.268	0.402	-0.261	-0.076	0.602	-0.150	0.495	0.402	0.336	0.547	-0.394	-0.407	-0.222	-0.426	0.639	-0.091	-0.245	0.244
35 Wool 64s	0.259	0.117	0.271	0.104	-0.321	0.469	0.136	0.107	-0.157	-0.336	-0.272	0.271	0.102	0.159	-0.157	0.088	0.244	-0.183	-0.155	-0.203	-0.386	0.295	-0.057	-0.571	0.196
36 Wool 50s	0.165	0.083	0.320	0.119	-0.289	0.478	0.265	0.423	-0.198	-0.266	-0.258	0.320	0.115	0.298	-0.198	0.204	0.166	-0.250	-0.079	0.020	-0.510	0.254	0.030	-0.559	0.259
37 Jute	-0.605	-0.236	-0.425	-0.131	-0.045	0.050	0.003	-0.252	-0.109	-0.053	0.057	-0.425	-0.142	-0.411	-0.109	-0.157	-0.195	0.133	0.038	0.155	0.402	-0.497	-0.471	0.317	-0.251
38 Sisal	0.118	0.597	0.458	0.100	-0.360	0.403	0.378	-0.207	0.283	-0.581	0.128	0.458	0.100	0.396	0.283	0.414	0.801	0.005	-0.461	-0.516	0.077	0.534	-0.015	-0.201	0.563
39 Lard	0.128	0.480	0.378	0.327	-0.136	0.146	0.074	-0.423	0.097	-0.338	0.164	0.378	0.330	0.217	0.097	0.219	0.436	-0.046	-0.361	-0.472	0.135	0.435	-0.223	-0.114	0.380
40 Soya oil	0.074	0.583	0.295	0.033	-0.257	0.150	0.133	-0.451	0.370	-0.488	0.341	0.295	0.036	0.265	0.370	0.181	0.578	-0.063	-0.436	-0.526	0.152	0.431	-0.309	0.031	0.380
41 Coffee	0.055	-0.016	0.144	0.134	0.073	-0.056	0.156	0.398	0.026	-0.005	0.464	0.144	0.136	0.499	0.026	0.253	-0.119	-0.269	0.371	0.401	-0.254	0.172	0.326	0.151	0.311
42 Cocoa	-0.032	0.135	0.243	0.151	-0.214	0.087	0.267	0.096	-0.025	-0.384	0.406	0.243	0.152	0.563	-0.025	0.299	0.167	-0.228	0.134	0.128	-0.219	0.309	-0.141	0.137	0.514
43 Sugar	0.061	0.210	-0.052	0.130	-0.050	0.004	-0.107	-0.269	0.275	-0.108	0.152	-0.052	0.128	-0.174	0.275	-0.098	0.184	-0.010	-0.198	-0.465	0.419	-0.025	0.123	0.123	-0.180
44 Tea	-0.183	-0.055	-0.145	0.070	0.067	-0.122	0.019	-0.048	0.123	-0.091	0.596	-0.145	0.071	0.160	0.123	0.060	-0.134	-0.159	0.233	0.192	0.093	-0.070	0.056	0.504	0.260
45 Wheat	0.492	0.541	0.505	-0.139	-0.259	0.325	0.205	-0.134	0.358	-0.388	-0.184	0.505	-0.135	0.289	0.358	0.218	0.747	-0.021	-0.561	-0.672	-0.107	0.578	-0.124	-0.456	0.320
46 Maize	0.486	0.487	0.443	0.084	-0.228	0.207	0.144	-0.120	0.328	-0.377	0.192	0.443	0.092	0.409	0.328	0.150	0.536	-0.177	-0.274	-0.409	-0.153	0.546	0.145	-0.720	0.375
47 Metal ores(UK)	0.106	0.332	0.592	0.912	-0.026	-0.031	-0.010	0.278	-0.237	-0.056	0.148	0.592	0.912	0.514	-0.237	0.565	0.113	-0.053	0.211	-0.057	-0.135	0.535	0.270	-0.300	0.349
48 Metals (UK)	0.152	0.585	0.892	0.382	-0.384	0.138	0.239	0.109	-0.014	-0.487	0.135	0.892	0.380	0.763	-0.014	0.718	0.642	0.020	-0.159	-0.089	-0.435	0.943	0.093	-0.035	0.714
49 Ag Non Foods	0.347	0.442	0.627	0.122	-0.399	0.461	0.313	0.010	0.078	-0.563	-0.077	0.627	0.122	0.505	0.078	0.372	0.651	-0.289	-0.409	-0.375	-0.367	0.682	-0.013	-0.424	0.535
50 Foods	0.078	0.145	0.159	-0.087	-0.314	0.291	0.105	-0.331	0.270	-0.328	-0.190	0.159	-0.088	-0.044	0.270	0.040	0.409	0.270	-0.499	-0.404	-0.034	0.184	-0.250	0.013	0.127

TABLE A2 (continued)

CORRELATION OF CHANGES IN REAL PRICE INDICES ON A YEAR EARLIER (PERCENTAGE) 1968 I - 1980 IV

	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
1 Iron ore																									
2 Steel scrap																									
3 Copper ore																									
4 Nickel "																									
5 Bauxite																									
6 Lead ore																									
7 Zinc "																									
8 Tin "																									
9 Manganese ore																									
10 Chrome "																									
11 Tungsten "																									
12 Copper scrap																									
13 Nickel "																									
14 Aluminium "																									
15 Manganese "																									
16 Lead "																									
17 Zinc "																									
18 Tin "																									
19 Ir & st sheets																									
20 Ir & st bars																									
21 I & s fe alloys																									
22 Copper																									
23 Nickel																									
24 Aluminium																									
25 Lead																									
26 Zinc	1.000																								
27 Tin	0.522	1.000																							
28 Hide	-0.034	-0.141	1.000																						
29 Soya beans	0.459	0.296	0.001	1.000																					
30 Rubber	0.643	0.351	0.248	0,452	1.000																				
31 Wood pulp	0.379	0.256	-0.489	0.024	-0.035	1.000																			
32 Hard wood	0.642	0.242	-0.236	0.382	0.620	0.202	1.000																		
33 Lumber	0.465	0.178	0.438	0.616	0.736	-0.315	0.510	1.000																	
34 Cotton	0.710	0.218	0.126	0.592	0.692	0.003	0.645	0.654	1.000																
35 Wool 64s	0.151	-0.061	0.396	0.406	0.512	-0.230	0.224	0.670	0.247	1.000															
36 Wool 50s	0.122	-0.027	0.684	0.354	0.520	-0.359	0.152	0.724	0.319	0.874	1.000														
37 Jute	-0.234	-0.079	-0.250	-0.172	-0.436	-0.014	-0.245	-0.338	-0.415	-0.433	-0.458	1.000													
38 Sisal	0.689	0.590	-0.075	0.492	0.532	0.433	0.537	0.525	0.376	0.450	0.361	-0.213	1.000												
39 Lard	0.551	0.309	-0.171	0.520	0.473	0.318	0.402	0.234	0.226	0.151	-0.002	0.026	0.458	1.000											
40 Soya oil	0.670	0.533	-0.391	0.706	0.404	0.415	0.482	0.269	0.440	0.065	-0.098	-0.011	0.605	0.822	1.000										
41 Coffee	-0.072	0.264	0.216	0.366	0.222	-0.229	-0.015	0.326	0.328	0.101	0.317	-0.397	-0.016	-0.144	-0.008	1.000									
42 Cocoa	0.208	0.499	0.153	0.603	0.516	-0.164	0.167	0.584	0.353	0.322	0.418	-0.133	0.355	0.262	0.338	0.654	1.000								
43 Sugar	0.077	0.127	-0.437	-0.075	-0.158	0.528	0.196	-0.265	-0.154	-0.092	-0.210	0.181	0.336	0.088	0.171	-0.358	-0.230	1.000							
44 Tea	-0.099	0.432	-0.123	0.476	-0.106	-0.031	-0.055	0.037	0.038	-0.085	-0.023	-0.017	0.055	0.101	0.702	0.658	0.589	-0.097	1.000						
45 Wheat	0.765	0.236	-0.036	0.489	0.659	0.377	0.598	0.488	0.585	0.457	0.317	-0.373	0.701	0.546	0.613	-0.210	0.087	0.174	-0.300	1.000					
46 Maize	0.584	0.360	-0.058	0.620	0.668	0.284	0.587	0.551	0.512	0.515	0.392	-0.450	0.698	0.570	0.615	0.175	0.387	0.155	0.087	0.761	1.000				
47 Metal ores (UK)	0.121	0.149	0.292	-0.034	0.396	0.042	0.130	0.139	0.073	0.202	0.252	-0.350	0.135	0.292	-0.005	0.229	0.205	0.050	0.001	0.021	0.196	1.000			
48 Metals (UK)	0.637	0.586	0.174	0.333	0.691	0.015	0.448	0.524	0.556	0.199	0.216	-0.457	0.476	0.348	0.368	0.325	0.412	-0.120	0.103	0.391	0.468	0.526	1.000		
49 Ag Non Foods	0.646	0.279	0.239	0.766	0.830	0.033	0.614	0.871	0.702	0.714	0.667	-0.434	0.705	0.532	0.559	0.231	0.540	-0.057	0.058	0.745	0.753	0.242	0.577	1.000	
50 Foods	0.429	0.289	-0.183	0.221	0.303	0.136	0.576	0.240	0.118	0.276	0.077	0.049	0.489	0.507	0.480	-0.365	-0.063	0.192	-0.045	0.532	0.521	-0.113	0.130	0.372	1.000

TABLE A3

CORRELATION OF CHANGES IN NOMINAL PRICE INDICES ON A YEAR EARLIER (PERCENTAGE) 1968I-1973IV

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1 Iron ore	1.000																								
2 Steel scrap	0.599	1.000																							
3 Copper ore	0.463	0.730	1.000																						
4 Nickel "	-0.125	0.420	0.490	1.000																					
5 Bauxite	-0.078	-0.092	-0.131	-0.317	1.000																				
6 Lead ore	0.152	0.035	0.344	-0.082	0.133	1.000																			
7 Zinc "	-0.024	-0.207	0.271	-0.116	0.085	0.847	1.000																		
8 Tin "	-0.170	-0.077	0.083	0.139	0.236	0.567	0.389	1.000																	
9 Manganese ore	0.495	0.282	0.274	-0.321	0.269	0.517	0.515	-0.144	1.000																
10 Chrome "	-0.679	-0.470	-0.650	-0.142	0.279	-0.268	-0.106	-0.133	-0.088	1.000															
11 Tungsten "	0.332	0.716	0.333	0.247	0.017	-0.423	-0.663	-0.371	-0.038	-0.129	1.000														
12 Copper scrap	0.463	0.730	1.000	0.490	-0.131	0.344	0.271	0.083	0.274	-0.650	0.333	1.000													
13 Nickel "	-0.118	0.426	0.484	0.999	-0.330	-0.101	-0.127	0.114	-0.317	-0.135	0.257	0.484	1.000												
14 Aluminium "	0.543	0.717	0.828	0.529	-0.448	-0.026	-0.026	-0.278	0.138	-0.647	0.415	0.828	0.538	1.000											
15 Manganese "	0.495	0.282	0.274	-0.321	0.269	0.517	0.515	-0.144	1.000	-0.088	-0.038	0.274	-0.317	0.138	1.000										
16 Lead "	0.093	0.543	0.853	0.618	-0.078	0.550	0.407	0.390	0.125	-0.472	0.148	0.853	0.603	0.563	0.125	1.000									
17 Zinc "	0.662	0.523	0.754	-0.037	0.052	0.633	0.550	0.082	0.656	-0.712	0.054	0.754	-0.043	0.570	0.657	0.596	1.000								
18 Tin "	0.393	0.793	0.646	0.437	0.118	0.330	0.110	0.073	0.475	-0.202	0.424	0.646	0.437	0.543	0.475	0.617	0.499	1.000							
19 Ir & st sheets	0.284	0.543	0.391	0.355	0.098	0.004	-0.395	0.373	-0.286	-0.459	0.532	0.391	0.337	0.230	-0.286	0.415	0.147	0.285	1.000						
20 Ir & st bars	-0.471	-0.433	-0.069	-0.111	0.352	0.504	0.528	0.210	0.180	0.416	-0.380	-0.069	-0.132	-0.353	0.180	0.196	0.002	0.046	-0.236	1.000					
21 I & s fe alloys	0.302	0.365	0.340	-0.066	0.431	0.409	0.329	-0.042	0.796	0.111	0.263	0.340	-0.069	0.119	0.796	0.292	0.488	0.587	-0.021	0.363	1.000				
22 Copper	0.585	0.783	0.936	0.418	-0.159	0.216	0.140	-0.127	0.372	-0.691	0.399	0.936	0.418	0.848	0.372	0.720	0.751	0.648	0.332	-0.243	0.319	1.000			
23 Nickel	0.187	0.476	-0.075	0.255	-0.091	-0.521	-0.830	-0.287	-0.232	0.043	0.738	-0.075	0.265	0.125	-0.232	-0.158	-0.322	0.244	0.465	-0.486	-0.090	0.066	1.000		
24 Aluminium	0.214	0.167	0.410	0.038	0.233	-0.043	0.024	-0.341	0.314	-0.072	0.372	0.410	0.033	0.288	0.314	0.236	-0.316	0.146	0.087	0.250	0.611	0.403	-0.096	1.000	
25 Lead	0.544	0.801	0.886	0.481	-0.267	0.218	0.093	0.171	0.181	-0.750	0.392	0.886	0.479	0.827	0.181	0.724	0.684	0.568	0.485	-0.397	0.206	0.850	0.080	0.192	1.000
26 Zinc	0.642	0.617	0.795	0.021	0.117	0.447	0.437	0.012	0.676	-0.561	0.208	0.795	0.018	0.606	0.676	0.553	0.912	0.530	0.173	-0.065	0.625	0.773	-0.259	0.490	0.741
27 Tin	0.594	0.848	0.888	0.336	0.004	0.347	0.210	0.063	0.491	-0.552	0.471	0.888	0.334	0.750	0.491	0.712	0.796	0.756	0.395	-0.142	0.596	0.842	0.030	0.405	0.635
28 Hide	-0.213	-0.116	0.054	0.244	-0.138	0.501	0.411	0.810	-0.205	-0.091	-0.487	0.054	0.233	-0.087	-0.205	0.313	-0.010	0.079	0.091	0.160	-0.245	-0.155	-0.279	-0.609	0.169
29 Soya beans	0.899	0.592	0.521	-0.168	0.052	0.450	0.263	-0.047	0.749	-0.600	0.201	0.521	-0.166	0.189	0.749	0.262	0.832	0.557	0.172	-0.205	0.568	0.603	0.001	0.242	0.561
30 Rubber	0.728	0.605	0.780	0.219	-0.389	0.313	0.249	-0.140	0.418	-0.765	0.200	0.780	0.222	0.864	0.418	0.516	0.798	0.496	0.140	-0.240	0.278	0.800	-0.084	0.267	0.803
31 Wood pulp	0.734	0.790	0.571	0.607	0.219	0.022	-0.118	-0.293	0.571	-0.374	0.660	0.571	0.015	0.557	0.570	0.259	0.633	0.608	0.343	-0.293	0.646	0.646	0.272	0.507	0.575
32 Hard wood	0.727	0.604	0.751	0.045	0.147	0.484	0.381	0.018	0.599	-0.586	0.255	0.751	0.041	0.607	0.699	0.538	0.906	0.603	0.210	0.007	0.706	0.739	-0.160	0.544	0.632
33 Lumber	0.668	0.368	0.594	-0.048	-0.077	0.685	0.576	0.213	0.561	-0.736	-0.159	0.594	-0.054	0.518	0.561	0.481	0.901	0.430	0.059	-0.012	0.312	0.575	-0.341	0.048	0.598
34 Cotton	0.722	0.471	0.633	-0.171	0.147	0.511	0.460	-0.066	0.832	-0.531	0.095	0.633	-0.175	0.452	0.832	0.390	0.888	0.466	0.051	-0.005	0.678	0.693	-0.245	0.512	0.552
35 Wool 64s	0.548	0.388	0.332	0.064	-0.397	0.480	0.248	0.215	0.234	-0.630	-0.107	0.332	0.061	0.407	0.234	0.279	0.526	0.364	0.175	-0.250	-0.113	0.362	0.049	-0.481	0.478
36 Wool 50s	0.387	0.276	0.244	0.074	-0.331	0.534	0.325	0.451	0.162	-0.481	-0.219	0.244	0.069	0.278	0.162	0.267	0.408	0.322	0.141	-0.143	-0.089	0.177	-0.068	-0.565	0.441
37 Jute	-0.273	-0.407	0.044	-0.163	0.357	0.411	0.448	0.179	0.110	0.175	-0.225	0.044	-0.184	-0.218	0.110	0.204	0.132	-0.109	-0.108	0.846	0.383	-0.157	-0.533	0.531	-0.231
38 Sisal	0.669	0.548	0.652	0.027	-0.191	0.576	0.504	0.156	0.590	-0.643	-0.027	0.652	0.027	0.602	0.590	0.465	0.854	0.530	0.077	-0.157	0.343	0.626	-0.240	-0.025	0.722
39 Lard	0.662	0.752	0.737	0.422	-0.197	0.171	0.045	-0.171	0.426	-0.519	0.493	0.787	0.426	0.831	0.426	0.564	0.634	0.705	0.287	-0.160	0.555	0.800	0.155	0.510	0.767
40 Soya oil	0.791	0.701	0.641	0.062	0.023	0.230	0.097	-0.269	0.710	-0.470	0.456	0.641	0.067	0.622	0.710	0.356	0.736	0.638	0.208	-0.164	0.722	0.736	0.125	0.573	0.613
41 Coffee	0.318	0.681	0.183	0.220	0.050	-0.055	-0.431	0.060	0.022	-0.179	0.687	0.183	0.223	0.148	0.022	0.171	0.095	0.433	0.627	-0.392	0.119	0.247	0.724	-0.181	0.346
42 Cocoa	0.643	0.371	0.605	0.147	-0.451	0.249	0.214	0.055	0.117	-0.857	-0.010	0.605	0.148	0.734	0.117	0.381	0.641	0.213	0.136	-0.356	-0.090	0.599	-0.186	0.014	0.715
43 Sugar	0.197	0.181	0.375	0.243	0.153	0.319	0.225	0.518	-0.052	-0.184	-0.070	0.375	0.231	0.223	-0.052	0.393	0.200	0.416	0.248	0.207	0.153	0.181	-0.212	0.070	0.295
44 Tea	0.202	0.508	0.155	0.039	0.454	0.209	-0.121	0.139	0.355	0.180	0.529	0.155	0.032	-0.071	0.355	0.201	0.161	0.585	0.406	0.165	0.650	0.127	0.455	0.206	0.126
45 Wheat	0.889	0.605	0.569	-0.111	-0.143	0.406	0.258	-0.058	0.692	-0.686	0.181	0.569	-0.106	0.578	0.692	0.285	0.824	0.497	0.137	-0.325	0.444	0.664	-0.014	0.169	0.656
46 Maize	0.917	0.736	0.596	0.039	-0.185	0.214	0.052	-0.204	0.574	-0.646	0.377	0.596	0.049	0.717	0.574	0.271	0.739	0.605	0.212	-0.403	0.409	0.691	0.174	0.178	0.634
47 Metal ores(UK)	0.125	0.595	0.702	0.944	-0.333	0.083	-0.005	0.187	-0.150	-0.395	0.297	0.702	0.942	0.690	-0.150	0.753	0.241	0.559	0.432	-0.188	0.029	0.640	0.216	0.060	0.709
48 Metals (UK)	0.535	0.780	0.963	0.423	-0.070	0.294	0.183	-0.030	0.381	-0.661	0.413	0.963	0.418	0.799	0.381	0.790	0.769	0.677	0.410	-0.124	0.403	0.983	0.036	0.464	0.854
49 Ag Non Foods	0.812	0.616	0.681	0.056	-0.173	0.529	0.359	0.045	0.607	-0.737	0.123	0.681	0.055	0.674	0.607	0.476	0.883	0.595	0.116	0.923	0.915	0.622	0.860	0.929	0.803
50 Foods	0.675	0.573	0.617	0.017	0.121	0.616	0.447	0.095	0.779	-0.443	0.155	0.617	0.013	0.492	0.779	0.484	0.842	0.713	0.126	0.124	0.749	0.498	-0.124	0.327	0.579

TABLE A3 (continued)

CORRELATION OF CHANGES IN NOMINAL PRICE INDICES ON A YEAR EARLIER (PERCENTAGE) 1968I-1973IV

	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
1 Iron ore																									
2 Steel scrap																									
3 Copper ore																									
4 Nickel "																									
5 Bauxite																									
6 Lead ore																									
7 Zinc "																									
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19 Ir & st sheets																									
20 Ir & st bars																									
21 I & s fe alloys																									
22 Copper																									
23 Nickel																									
24 Aluminium																									
25 Lead																									
26 Zinc	1.000																								
27 Tin	0.894	1.000																							
28 Hide	-0.116	-0.009	1.000																						
29 Soya beans	0.790	0.719	0.107	1.000																					
30 Rubber	0.752	0.781	0.021	0.765	1.000																				
31 Wood pulp	0.777	0.802	-0.457	0.762	0.570	1.000																			
32 Hard wood	0.929	0.873	-0.119	0.873	0.792	0.790	1.000																		
33 Lumber	0.720	0.629	0.261	0.822	0.812	0.417	0.798	1.000																	
34 Cotton	0.911	0.736	-0.215	0.879	0.716	0.713	0.912	0.746	1.000																
35 Wool 64s	0.294	0.359	0.445	0.589	0.620	0.132	0.346	0.734	0.322	1.000															
36 Wool 50s	0.228	0.318	0.709	0.469	0.507	0.008	0.277	0.675	0.198	0.917	1.000														
37 Jute	0.103	-0.027	0.030	-0.102	-0.077	-0.117	0.203	0.086	0.122	-0.357	-0.232	1.000													
38 Sisal	0.799	0.757	0.274	0.819	0.835	0.512	0.765	0.886	0.739	0.767	0.730	-0.136	1.000												
39 Lard	0.707	0.859	-0.130	0.700	0.849	0.726	0.817	0.569	0.661	0.321	0.245	-0.004	0.611	1.000											
40 Soya oil	0.815	0.817	-0.369	0.875	0.757	0.875	0.893	0.594	0.868	0.280	0.136	-0.031	0.639	0.879	1.000										
41 Coffee	0.106	0.363	-0.056	0.251	0.057	0.443	0.141	-0.002	0.023	0.323	0.241	-0.449	0.153	0.228	0.260	1.000									
42 Cocoa	0.520	0.529	0.245	0.588	0.878	0.271	0.567	0.781	0.478	0.668	0.618	-0.133	0.729	0.612	0.451	-0.066	1.000								
43 Sugar	0.211	0.321	0.493	0.205	0.266	0.080	0.311	0.336	0.124	0.150	0.327	0.296	0.259	0.354	0.129	-0.167	0.357	1.000							
44 Tea	0.246	0.412	-0.124	0.337	-0.039	0.506	0.351	0.026	0.235	0.025	0.026	0.062	0.114	0.300	0.420	0.677	-0.313	0.121	1.000						
45 Wheat	0.790	0.728	-0.031	0.957	0.849	0.605	0.850	0.828	0.860	0.656	0.546	-0.202	0.872	0.714	0.837	0.226	0.706	0.151	0.169	1.000					
46 Maize	0.728	0.763	-0.124	0.923	0.867	0.789	0.798	P.745	0.742	0.635	0.499	-0.284	0.812	0.807	0.861	0.332	0.694	0.200	0.235	0.940	1.000				
47 Metal ores(UK)	0.269	0.561	0.273	0.096	0.466	0.181	0.297	0.220	0.085	0.276	0.254	-0.192	0.297	0.605	0.272	0.314	0.385	0.303	0.098	0.171	0.285	1.000			
48 Metals (UK)	0.804	0.881	-0.117	0.591	0.762	0.657	0.775	0.568	0.712	0.317	0.163	-0.033	0.616	0.800	0.737	0.270	0.541	0.229	0.222	0.630	0.644	0.644	1.000		
49 Ag Non Foods	0.784	0.781	0.116	0.923	0.915	0.622	0.860	0.929	0.803	0.754	0.657	-0.083	0.927	0.768	0.791	0.204	0.785	0.289	0.182	0.943	0.919	0.334	0.693	1.000	
50 Foods	0.814	0.806	0.048	0.894	0.738	0.691	0.926	0.824	0.839	0.511	0.478	0.169	0.819	0.763	0.842	0.202	0.493	0.345	0.476	0.831	0.803	0.251	0.637	0.852	1.000

TABLE A4

CORRELATION OF CHANGES IN REAL PRICE INDICES ON A YEAR EARLIER (PERCENTAGE) 1968 I - 1973 IV

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1 Iron ore	1.000																								
2 Steel scrap	0.385	1.000																							
3 Copper ore	0.139	0.636	1.000																						
4 Nickel "	-0.221	0.431	0.537	1.000																					
5 Bauxite	-0.259	-0.439	-0.560	-0.242	1.000																				
6 Lead ore	-0.286	-0.243	0.147	-0.152	-0.361	1.000																			
7 Zinc "	-0.377	-0.505	0.073	-0.162	-0.178	0.802	1.000																		
8 Tin "	-0.338	-0.158	0.014	0.125	0.047	0.553	0.350	1.000																	
9 Manganese ore	0.132	-0.060	-0.119	-0.480	-0.157	0.309	0.382	-0.305	1.000																
10 Chrome "	-0.493	-0.448	-0.666	-0.087	0.706	-0.357	-0.086	-0.129	-0.044	1.000															
11 Tungsten "	0.249	0.691	0.238	0.246	-0.034	-0.640	-0.847	-0.417	-0.264	-0.041	1.000														
12 Copper scrap	0.139	0.636	1.000	0.537	-0.560	0.147	0.073	0.014	-0.119	-0.666	0.238	1.000													
13 Nickel "	-0.210	0.459	0.531	0.999	-0.243	-0.170	-0.171	0.102	-0.472	-0.078	0.256	0.531	1.000												
14 Aluminium "	0.367	0.642	0.790	0.568	-0.573	-0.262	-0.210	-0.352	-0.193	-0.530	0.356	0.790	0.577	1.000											
15 Manganese "	0.132	-0.060	-0.119	-0.480	-0.157	0.309	0.382	-0.305	1.000	-0.044	-0.264	-0.119	-0.472	-0.193	1.000										
16 Lead "	-0.305	0.436	0.831	0.648	-0.477	0.430	0.260	0.348	-0.233	-0.505	0.051	0.831	0.633	0.492	-0.233	1.000									
17 Zinc "	0.328	0.293	0.631	-0.123	-0.621	0.517	0.414	-0.016	0.393	-0.853	-0.166	0.631	-0.129	0.413	0.393	0.469	1.000								
18 Tin "	-0.067	0.610	0.312	0.534	0.009	-0.195	-0.293	-0.078	-0.021	0.143	0.380	0.312	0.541	0.354	-0.021	0.326	-0.162	1.000							
19 Ir & st sheets	0.052	0.187	-0.032	0.296	0.403	-0.481	-0.634	0.207	-0.777	0.137	0.420	-0.032	0.287	0.004	-0.777	0.012	-0.485	0.114	1.000						
20 Ir & st bars	-0.608	-0.687	-0.477	-0.082	0.671	-0.097	0.167	0.017	-0.241	0.781	-0.301	-0.477	-0.089	-0.451	-0.241	-0.249	-0.643	-0.039	0.213	1.000					
21 I & s fe alloys	-0.299	-0.079	-0.210	-0.175	0.190	-0.058	0.023	-0.270	0.578	0.423	0.148	-0.210	-0.171	-0.316	0.578	-0.177	-0.162	0.164	-0.410	0.134	1.000				
22 Copper	0.336	0.707	0.913	0.450	-0.500	-0.017	-0.074	-0.223	0.044	-0.661	0.318	0.913	0.451	0.801	0.044	0.664	0.629	0.359	-0.031	-0.548	-0.200	1.000			
23 Nickel	0.131	0.236	-0.305	0.205	0.420	-0.755	-0.818	-0.279	-0.447	0.453	0.587	-0.305	0.217	-0.001	-0.447	-0.358	-0.711	0.322	0.683	0.206	-0.145	-0.139	1.000		
24 Aluminium	-0.095	-0.218	-0.002	0.019	0.397	-0.536	-0.252	-0.468	-0.126	0.347	0.291	-0.002	0.021	0.050	-0.126	-0.143	-0.283	-0.137	0.203	0.430	0.404	0.036	0.202	1.000	
25 Lead	0.269	0.711	0.821	0.549	-0.561	-0.083	-0.175	0.121	-0.308	-0.671	0.323	0.821	0.549	0.796	-0.308	0.640	0.459	0.228	0.186	-0.627	-0.439	0.774	-0.060	-0.174	1.000
26 Zinc	0.316	0.442	0.689	-0.037	-0.570	0.296	0.263	-0.081	0.448	-0.713	0.039	0.689	-0.040	0.462	0.448	0.429	0.872	-0.061	-0.454	-0.695	0.131	0.656	-0.638	-0.082	0.544
27 Tin	0.212	0.823	0.855	0.458	-0.559	-0.059	-0.165	-0.078	-0.009	-0.586	0.469	0.855	0.460	0.758	-0.009	0.637	0.543	0.488	-0.050	-0.602	0.009	0.791	-0.199	-0.069	0.845
28 Hide	-0.326	-0.169	0.012	0.245	-0.097	0.478	0.397	0.800	-0.336	-0.024	-0.501	0.012	0.233	-0.100	-0.336	0.279	-0.110	0.055	0.072	0.114	-0.443	-0.227	-0.187	-0.616	0.173
29 Soya beans	0.739	0.395	0.254	-0.317	-0.554	0.214	0.002	-0.194	0.555	-0.690	0.028	0.254	-0.312	0.285	0.555	-0.045	0.703	-0.036	-0.432	-0.797	0.007	0.381	-0.359	-0.366	0.250
30 Rubber	0.493	0.466	0.710	0.216	-0.798	0.115	0.065	-0.238	0.094	-0.783	0.071	0.710	0.220	0.825	0.094	0.413	0.716	0.043	-0.319	-0.643	-0.316	0.712	-0.368	-0.190	0.705
31 Wood pulp	0.522	0.688	0.460	-0.048	-0.402	-0.133	-0.305	-0.369	0.399	-0.525	0.533	0.460	-0.041	0.423	0.399	0.138	0.566	0.173	-0.219	-0.759	0.316	0.537	-0.164	0.013	0.387
32 Hard wood	0.399	0.393	0.625	-0.021	-0.595	0.239	0.145	-0.139	0.423	-0.755	0.095	0.625	-0.025	0.484	0.423	0.364	0.827	-0.058	-0.490	-0.710	0.188	0.602	-0.606	-0.012	0.452
33 Lumber	0.378	0.047	0.383	-0.140	-0.591	0.553	0.474	0.157	0.236	-0.773	-0.456	0.383	-0.145	0.361	0.236	0.275	0.810	-0.210	-0.472	-0.506	-0.450	0.355	-0.640	-0.526	0.353
34 Cotton	0.435	0.224	0.445	-0.298	-0.471	0.343	0.297	-0.202	0.694	-0.639	-0.108	0.445	-0.300	0.239	0.694	0.178	0.824	-0.171	-0.561	-0.607	0.228	0.545	-0.608	-0.020	0.249
35 Wool 64s	0.397	0.288	0.224	0.032	-0.613	0.407	0.147	0.189	0.032	-0.598	-0.217	0.224	0.030	0.311	0.032	0.180	0.457	0.062	-0.146	-0.501	-0.644	0.248	-0.167	-0.819	0.375
36 Wool 50s	0.198	0.155	0.111	0.048	-0.527	0.459	0.231	0.438	-0.057	-0.443	-0.327	0.111	0.043	0.176	-0.057	0.156	0.286	0.037	-0.149	-0.380	-0.570	0.016	-0.230	-0.871	0.336
37 Jute	-0.529	-0.642	-0.139	-0.180	0.256	0.253	0.362	0.105	-0.083	0.257	-0.264	-0.139	-0.198	-0.329	-0.083	0.049	-0.103	-0.352	-0.127	0.614	0.332	-0.359	-0.372	0.499	-0.452
38 Sisal	0.376	0.360	0.496	-0.026	-0.749	0.463	0.367	0.104	0.339	-0.726	-0.233	0.496	-0.026	0.462	0.339	0.311	0.776	0.001	-0.491	-0.690	-0.292	0.450	-0.572	-0.629	0.540
39 Lard	0.357	0.664	0.716	0.455	-0.692	-0.083	-0.208	-0.282	0.089	-0.579	0.415	0.716	0.460	0.780	0.089	0.474	0.459	0.340	-0.227	-0.635	0.125	0.703	-0.195	0.042	0.633
40 Soya oil	0.528	0.574	0.482	0.013	-0.586	-0.028	-0.179	-0.432	0.501	-0.577	0.359	0.482	0.019	0.481	0.501	0.171	0.594	0.147	-0.386	-0.736	0.343	0.598	-0.268	0.051	0.363
41 Coffee	0.170	0.581	-0.046	0.207	0.027	-0.338	-0.666	-0.004	-0.285	-0.001	0.659	-0.046	0.212	-0.002	-0.285	-0.032	-0.266	0.299	0.528	-0.294	-0.196	0.059	0.647	-0.285	0.167
42 Cocoa	0.508	0.214	0.513	0.139	-0.553	0.066	0.083	0.015	-0.218	-0.705	-0.114	0.513	0.141	0.684	-0.218	0.265	0.527	-0.138	-0.081	-0.453	-0.650	0.490	-0.271	-0.236	0.662
43 Sugar	0.023	0.050	0.248	0.242	0.041	0.139	0.096	0.474	-0.336	-0.052	-0.116	0.248	0.232	0.136	-0.336	0.266	-0.053	0.338	0.114	0.083	-0.088	0.026	-0.169	-0.056	0.160
44 Tea	-0.174	0.286	-0.251	0.001	0.261	-0.183	-0.466	0.031	-0.000	0.370	0.500	-0.251	-0.001	-0.381	-0.000	-0.137	-0.417	0.360	0.222	0.018	0.453	-0.249	0.436	-0.010	-0.285
45 Wheat	0.708	0.440	0.377	-0.208	-0.691	0.217	0.046	-0.159	0.487	-0.767	0.016	0.377	-0.202	0.424	0.487	0.065	0.738	-0.067	-0.426	-0.841	-0.142	0.497	-0.371	-0.415	0.457
46 Maize	0.777	0.635	0.429	-0.009	-0.666	-0.004	-0.215	-0.333	0.321	-0.684	0.274	0.429	0.003	0.620	0.321	0.061	0.600	0.177	-0.286	-0.831	-0.134	0.545	-0.148	-0.340	0.503
47 Metal ores (UK)	-0.091	0.541	0.659	0.969	-0.360	-0.099	-0.141	0.148	-0.467	-0.274	0.253	0.669	0.968	0.668	-0.467	0.714	0.038	0.493	0.269	-0.234	-0.304	0.595	0.138	-0.067	0.698
48 Metals (UK)	0.200	0.655	0.904	0.515	-0.339	-0.104	-0.130	-0.179	-0.117	-0.531	0.362	0.904	0.513	0.761	-0.117	0.695	0.481	0.382	0.157	-0.360	-0.210	0.964	-0.031	0.182	0.757
49 Ag Non Foods	0.580	0.441	0.527	0.002	-0.790	0.333	0.146	-0.067	0.293	-0.845	-0.076	0.527	0.003	0.585	0.293	0.290	0.795	0.032	-0.413	-0.765	-0.316	0.560	-0.449	-0.508	0.548
50 Foods	0.291	0.314	0.338	-0.091	-0.637	0.398	0.237	-0.079	0.599	-0.542	-0.097	0.338	-0.092	0.305	0.599	0.191	0.654	0.165	-0.680	-0.598	0.270	0.315	-0.583	-0.364	0.197

TABLE A4 (continued)

CORRELATION OF CHANGES IN REAL PRICE INDICES ON A YEAR EARLIER (PERCENTAGE) 1968 I - 1973 IV

	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
1 Iron ore																									
2 Steel scrap																									
3 Copper ore																									
4 Nickel "																									
5 Bauxite																									
6 Lead ore																									
7 Zinc "																									
8 Tin "																									
9 Manganese ore																									
10 Chrome "																									
11 Tungsten "																									
12 Copper scrap																									
13 Nickel "																									
14 Aluminium "																									
15 Manganese "																									
16 Lead "																									
17 Zinc "																									
18 Tin "																									
19 Ir & st sheets																									
20 Ir & st bars																									
21 I & s fe alloys																									
22 Copper																									
23 Nickel																									
24 Aluminium																									
25 Lead																									
26 Zinc	1.000																								
27 Tin	0.750	1.000																							
28 Hide	-0.217	-0.088	1.000																						
29 Soya beans	0.674	0.387	-0.242	1.000																					
30 Rubber	0.668	0.677	-0.223	0.631	1.000																				
31 Wood pulp	0.767	0.713	-0.538	0.725	0.487	1.000																			
32 Hard wood	0.907	0.664	-0.288	0.745	0.708	0.792	1.000																		
33 Lumber	0.544	0.242	0.270	0.657	0.721	0.205	0.595	1.000																	
34 Cotton	0.869	0.438	-0.371	0.791	0.571	0.674	0.846	0.554	1.000																
35 Wool 64s	0.190	0.177	0.430	0.527	0.563	0.047	0.170	0.720	0.181	1.000															
36 Wool 50s	0.094	0.127	0.715	0.359	0.430	-0.102	0.069	0.644	0.005	0.903	1.000														
37 Jute	-0.124	-0.323	-0.001	-0.421	-0.267	-0.306	-0.015	-0.136	-0.107	-0.519	-0.368	1.000													
38 Sisal	0.713	0.545	0.263	0.717	0.772	0.417	0.622	0.814	0.599	0.769	0.719	-0.390	1.000												
39 Lard	0.605	0.797	-0.207	0.514	0.788	0.674	0.740	0.309	0.475	0.186	0.104	-0.195	0.459	1.000											
40 Soya oil	0.746	0.641	-0.534	0.790	0.641	0.880	0.839	0.307	0.787	0.129	-0.056	-0.273	0.475	0.818	1.000										
41 Coffee	-0.226	0.142	-0.079	-0.044	-0.214	0.191	-0.273	-0.384	-0.336	0.186	0.102	-0.562	-0.137	-0.031	-0.019	1.000									
42 Cocoa	0.373	0.402	0.251	0.427	0.837	0.120	0.424	0.751	0.283	0.600	0.556	-0.236	0.639	0.480	0.243	-0.239	1.000								
43 Sugar	-0.008	0.167	0.483	-0.040	0.108	-0.099	0.093	0.152	-0.144	0.019	0.226	0.234	0.068	0.217	-0.100	-0.287	0.268	1.000							
44 Tea	-0.241	-0.035	-0.202	-0.126	-0.522	0.180	-0.203	-0.611	-0.261	-0.257	-0.239	-0.088	-0.379	-0.077	0.043	0.619	-0.698	-0.032	1.000						
45 Wheat	0.712	0.487	-0.111	0.933	0.770	0.651	0.724	0.712	0.781	0.621	0.479	-0.488	0.822	0.564	0.744	-0.042	0.592	-0.081	-0.310	1.000					
46 Maize	0.616	0.596	-0.209	0.886	0.802	0.747	0.687	0.585	0.600	0.584	0.418	-0.556	0.731	0.715	0.787	0.109	0.583	0.017	-0.172	0.907	1.000				
47 Metal ores(UK)	0.093	0.562	0.267	-0.187	0.370	0.024	0.094	0.014	-0.172	0.178	0.160	-0.277	0.135	0.530	0.090	0.234	0.311	0.240	-0.081	-0.041	0.125	1.000			
48 Metals (UK)	0.535	0.747	-0.209	0.161	0.573	0.410	0.451	0.180	0.393	0.097	-0.110	-0.253	0.269	0.597	0.441	0.081	0.398	0.054	-0.213	0.285	0.345	0.636	1.000		
49 Ag Non Foods	0.673	0.540	0.074	0.846	0.892	0.527	0.723	0.863	0.653	0.769	0.637	-0.395	0.902	0.639	0.648	-0.116	0.744	0.083	-0.393	0.911	0.882	0.167	0.360	1.000	
50 Foods	0.674	0.459	-0.049	0.784	0.612	0.613	0.795	0.623	0.680	0.426	0.391	-0.101	0.727	0.636	0.736	-0.249	0.298	0.164	-0.028	0.724	0.713	-0.023	0.112	0.777	1.000

TABLE A5

CORRELATION OF CHANGES IN NOMINAL PRICE INDICES ON A YEAR EARLIER (PERCENTAGE) 1974I-1980IV

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1 Iron ore	1.000																								
2 Steel scrap	0.075	1.000																							
3 Copper ore	0.187	0.577	1.000																						
4 Nickel "	0.144	0.144	0.124	1.000																					
5 Bauxite	0.626	-0.120	-0.441	-0.039	1.000																				
6 Lead ore	0.373	0.710	0.451	-0.165	0.119	1.000																			
7 Zinc "	0.208	0.615	0.336	-0.227	0.252	0.856	1.000																		
8 Tin "	-0.218	-0.124	0.220	-0.242	-0.118	-0.178	0.068	1.000																	
9 Manganese ore	0.497	0.482	-0.006	-0.103	0.439	0.816	0.676	-0.286	1.000																
10 Chromium "	0.515	-0.347	-0.531	-0.313	0.880	-0.055	0.068	0.077	0.306	1.000															
11 Tungsten "	-0.147	0.389	-0.274	0.386	0.231	0.299	0.453	-0.212	0.477	-0.017	1.000														
12 Copper scrap	0.187	0.577	1.000	0.124	-0.441	0.451	0.336	0.220	-0.006	-0.531	-0.274	1.000													
13 Nickel "	0.144	0.145	0.124	1.000	-0.038	-0.165	-0.227	-0.242	-0.103	-0.313	0.386	0.124	1.000												
14 Aluminium "	-0.226	0.629	0.733	0.123	-0.488	0.422	0.527	0.378	-0.020	-0.614	0.178	0.773	0.123	1.000											
15 Manganese "	0.497	0.482	-0.006	-0.103	0.439	0.816	0.676	-0.286	1.000	0.306	0.477	-0.006	-0.103	-0.020	1.000										
16 Lead "	-0.032	0.681	0.804	0.326	-0.382	0.402	0.392	0.179	-0.044	-0.611	0.058	0.804	0.326	0.835	-0.044	1.000									
17 Zinc "	0.323	0.885	0.758	0.207	-0.129	0.766	0.598	-0.187	0.465	-0.381	0.177	0.758	0.207	0.619	0.465	0.773	1.000								
18 Tin "	-0.171	0.297	0.098	0.054	-0.263	0.051	-0.113	-0.391	-0.140	-0.337	-0.125	0.098	0.054	0.001	-0.140	0.293	0.308	1.000							
19 Ir & st sheets	-0.022	-0.079	-0.595	0.421	0.442	-0.257	-0.212	-0.225	0.010	0.290	0.467	-0.595	0.421	-0.389	0.010	-0.204	-0.256	0.250	1.000						
20 Ir & st bars	-0.247	-0.008	-0.434	0.077	0.281	-0.084	0.117	-0.039	-0.045	0.194	0.458	-0.434	0.077	-0.117	-0.045	-0.072	-0.157	0.336	0.707	1.000					
21 I & s fe alloys	0.419	0.186	-0.405	0.434	0.651	0.195	0.119	-0.492	0.495	0.403	0.549	-0.405	0.434	-0.398	0.495	-0.173	0.121	0.192	0.737	0.464	1.000				
22 Copper	0.232	0.614	0.963	0.242	-0.423	0.549	0.395	0.048	0.115	-0.569	-0.119	0.963	0.242	0.767	0.115	0.803	0.808	0.092	-0.545	-0.421	-0.282	1.000			
23 Nickel	0.584	-0.185	0.035	0.587	0.359	-0.126	-0.147	-0.125	0.041	0.219	0.030	0.035	0.587	-0.152	0.041	-0.012	0.061	-0.177	0.144	-0.166	0.342	0.099	1.000		
24 Aluminium	0.010	0.114	-0.369	0.472	0.083	0.112	-0.073	-0.718	0.292	-0.121	0.570	-0.369	0.472	-0.277	0.292	-0.103	0.116	0.361	0.556	0.361	0.656	-0.180	0.162	1.000	
25 Lead	0.015	0.532	0.637	0.495	-0.275	0.337	0.331	-0.198	-0.063	-0.605	0.192	0.637	0.495	0.632	-0.063	0.828	0.681	0.302	-0.081	0.038	-0.008	0.722	0.079	0.172	1.000
26 Zinc	0.368	0.781	0.743	-0.067	-0.101	0.908	0.728	-0.099	0.594	-0.272	0.086	0.743	-0.067	0.594	0.594	0.618	0.885	0.066	-0.432	-0.284	-0.030	0.801	-0.134	-0.059	0.524
27 Tin	-0.090	0.759	0.393	0.177	-0.250	0.708	0.643	-0.339	0.478	-0.460	0.583	0.393	0.177	0.578	0.478	0.535	0.727	0.293	-0.067	0.144	0.138	0.538	-0.205	0.444	0.626
28 Hide	-0.241	-0.026	0.441	-0.193	-0.240	-0.212	-0.025	0.612	-0.578	-0.156	-0.438	0.441	-0.193	-0.240	-0.220	-0.025	0.612	-0.578	-0.350	-0.040	-0.577	0.275	-0.211	-0.669	0.292
29 Soya beans	-0.084	0.367	0.243	0.383	-0.151	0.278	0.232	-0.312	0.143	-0.480	0.388	0.243	0.383	0.358	0.143	0.404	0.364	-0.167	-0.057	-0.171	0.064	0.367	-0.103	0.267	0.578
30 Rubber	0.075	0.451	0.882	-0.063	-0.488	0.478	0.425	0.244	0.003	-0.558	-0.255	0.882	-0.063	0.199	0.003	0.739	0.619	-0.026	-0.678	-0.479	-0.536	0.869	-0.097	-0.426	0.567
31 Wood pulp	0.699	0.517	0.077	0.413	0.607	0.524	0.408	-0.361	0.712	0.326	0.456	0.077	0.413	-0.064	0.712	0.131	0.544	0.048	0.341	0.096	0.781	0.178	0.466	0.379	0.197
32 Hard wood	0.479	0.267	0.387	0.255	-0.151	0.470	0.107	-0.408	0.385	-0.294	-0.041	0.387	0.255	0.142	0.385	0.254	0.498	0.142	-0.156	-0.420	0.153	0.510	0.344	0.367	0.250
33 Lumber	-0.116	0.381	0.703	0.230	-0.545	0.303	0.253	0.023	-0.157	-0.755	-0.017	0.703	0.230	0.761	-0.157	0.755	0.530	0.084	-0.382	-0.226	-0.376	0.750	-0.045	-0.073	0.740
34 Cotton	0.472	0.388	0.696	-0.093	-0.277	0.484	0.429	0.318	0.207	-0.320	-0.089	0.696	-0.093	0.675	0.207	0.493	0.464	-0.452	-0.652	-0.606	-0.451	0.702	-0.093	-0.441	0.235
35 Wool 64s	-0.127	-0.301	0.415	0.256	-0.633	-0.393	-0.511	0.060	-0.628	-0.545	-0.493	0.415	0.256	0.221	-0.628	0.222	-0.053	-0.071	-0.446	-0.463	-0.619	0.405	0.212	-0.172	0.290
36 Wool 50s	-0.218	-0.105	0.554	0.117	-0.534	-0.204	-0.100	0.513	-0.539	-0.458	-0.287	0.554	0.117	0.601	-0.539	0.423	0.013	-0.337	-0.506	-0.329	-0.705	0.509	0.033	-0.529	0.350
37 Jute	-0.149	0.179	-0.509	0.179	0.183	0.613	-0.114	-0.482	0.213	0.059	0.412	-0.509	0.179	0.183	0.013	-0.114	-0.482	0.213	0.059	0.412	-0.509	0.179	-0.405	0.213	-0.165
38 Sisa	0.254	0.774	0.510	0.447	-0.102	0.702	0.540	-0.354	0.524	-0.432	0.475	0.510	0.447	0.544	0.524	0.650	0.857	0.290	-0.004	-0.037	0.316	0.655	0.246	0.445	0.654
39 Lard	0.255	0.483	0.119	0.063	0.251	0.586	0.458	-0.568	0.478	-0.108	0.266	0.119	0.063	0.842	0.478	0.284	0.544	0.313	0.121	0.105	0.446	0.221	-0.104	0.411	0.452
40 Soya oil	0.093	0.681	0.242	0.154	0.009	0.689	0.551	-0.494	0.564	-0.348	0.499	0.242	0.154	0.322	0.564	0.390	0.657	0.208	0.037	0.051	0.340	0.374	-0.173	0.459	0.492
41 Coffee	-0.259	-0.144	0.076	0.198	-0.112	-0.045	0.276	0.303	-0.142	-0.210	0.359	0.076	0.198	0.474	-0.142	0.176	-0.133	-0.564	-0.170	0.009	-0.285	0.137	0.103	-0.181	0.267
42 Cocoa	-0.356	0.135	0.050	0.232	-0.210	0.203	0.390	-0.019	0.052	-0.423	0.586	0.050	0.232	0.478	0.052	0.281	0.076	-0.294	-0.002	0.217	-0.088	0.184	-0.206	0.187	0.468
43 Sugar	0.334	0.356	-0.050	0.370	0.115	0.260	0.012	-0.401	0.574	-0.004	0.351	-0.050	0.370	-0.168	0.574	-0.091	0.323	0.125	0.149	-0.195	0.520	0.050	0.343	0.477	-0.114
44 Tea	-0.205	0.010	-0.178	0.306	0.031	0.120	0.235	-0.270	0.153	-0.218	0.639	-0.178	0.306	0.134	0.153	0.010	0.001	-0.301	0.141	0.212	0.150	-0.031	-0.012	0.490	0.308
45 Wheat	0.500	0.714	0.658	0.060	-0.025	0.734	0.444	-0.241	0.512	-0.228	-0.114	0.658	0.060	0.346	0.512	0.557	0.848	0.334	-0.267	-0.357	0.156	0.688	0.073	0.066	0.427
46 Maize	0.262	0.493	0.423	0.299	-0.056	0.621	0.522	-0.221	0.549	-0.332	0.331	0.423	0.299	0.364	0.549	0.413	0.634	-0.019	-0.230	-0.299	0.092	0.533	0.292	0.188	0.487
47 Metal ores (UK)	0.581	0.429	0.488	0.694	0.228	0.283	0.226	0.115	0.253	-0.014	0.232	0.488	0.694	0.344	0.253	0.519	0.551	-0.118	0.150	-0.066	0.387	0.531	0.583	0.070	0.455
48 Metals (UK)	0.187	0.719	0.831	0.290	-0.343	0.675	0.533	-0.152	0.262	-0.566	0.145	0.831	0.290	0.741	0.262	0.807	0.887	0.248	-0.337	-0.127	-0.067	0.920	0.038	0.113	0.813
49 Ag Non Foods	0.246	0.626	0.729	0.407	-0.254	0.545	0.381	-0.245	0.215	-0.580	0.145	0.729	0.407	0.635	0.215	0.736	0.777	0.036	-0.300	-0.338	-0.021	0.832	0.134	0.109	0.788
50 Foods	0.295	0.366	0.019	0.134	0.068	0.454	0.123	-0.710	0.442	-0.112	0.127	0.019	0.134	-0.202	0.442	0.102	0.478	0.642	0.252	0.142	0.516	0.130	0.036	0.712	0.243

TABLE A5 (continued)

CORRELATION OF CHANGES IN NOMINAL PRICE INDICES ON A YEAR EARLIER (PERCENTAGE) 1974I-1980IV

	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
1 Iron ore																									
2 Steel scrap																									
3 Copper ore																									
4 Nickel "																									
5 Bauxite																									
6 Lead ore																									
7 Zinc "																									
8 Tin "																									
9 Manganese ore																									
10 Chromium "																									
11 Tungsten "																									
12 Copper scrap																									
13 Nickel "																									
14 Aluminium "																									
15 Manganese "																									
16 Lead "																									
17 Zinc "																									
18 Tin "																									
19 Ir & st sheets																									
20 Ir & st bars																									
21 I & s fe alloys																									
22 Copper																									
23 Nickel																									
24 Aluminium																									
25 Lead																									
26 Zinc	1.000																								
27 Tin	0.688	1.00																							
28 Hide	0.019	-0.226	1.000																						
29 Soya beans	0.376	0.448	-0.050	1.000																					
30 Rubber	0.723	0.383	0.388	0.312	1.000																				
31 Wood pulp	0.416	0.334	-0.433	0.113	-0.125	1.000																			
32 Hard wood	0.518	0.342	-0.469	0.202	0.423	0.354	1.000																		
33 Lumber	0.517	0.448	0.295	0.567	0.809	-0.150	0.442	1.000																	
34 Cotton	0.671	0.253	0.257	0.443	0.831	-0.026	0.378	0.664	1.000																
35 Wool 64s	-0.100	-0.165	0.354	0.153	0.407	-0.506	0.233	0.529	0.295	1.000															
36 Wool 50s	0.060	-0.086	0.641	0.170	0.616	-0.497	-0.027	0.646	0.595	0.763	1.000														
37 Jute	-0.156	0 171	-0.454	0.107	-0.538	0.280	-0.035	-0.347	-0.559	-0.551	-0.728	1.000													
38 Sisal	0.708	0.816	-0.323	0.449	0.427	0.608	0.630	0.527	0.319	-0.070	-0.075	0.095	1.000												
39 Lard	0.535	0.509	-0.245	0.610	0.131	0.464	0.298	0.225	0.063	-0.361	-0.464	0.429	0.538	1.000											
40 Soya oil	0.650	0.748	-0.340	0.736	0.266	0.449	0.402	0.413	0.285	-0.279	-0.294	0.345	0.738	0.876	1.000										
41 Coffee	-0.052	0.120	0.176	0.410	0.267	-0.251	-0.199	0.420	0.382	0.247	0.581	-0.476	0.034	-0.174	0.016	1.000									
42 Cocoa	0.174	0.500	0.002	0.671	0.269	-0.138	-0.038	0.538	0.338	0.081	0.344	-0.042	0.278	0.219	0.442	0.782	1.000								
43 Sugar	0.176	0.272	-0.699	0.058	-0.209	0.655	0.441	-0.243	-0.094	-0.263	-0.510	0.334	0.502	0.222	0.371	-0.349	-0.238	1.000							
44 Tea	0.021	0.425	-0.234	0.699	-0.105	0.037	-0.012	0.244	0.059	0.012	0.017	0.091	0.264	0.370	0.522	0.598	0.789	0.006	1.000						
45 Wheat	0.064	0.460	-0.104	0.260	0.560	0.541	0.605	0.368	0.439	-0.113	-0.161	0.017	0.695	0.609	0.602	-0.368	-0.195	-0.411	-0.241	1.000					
46 Maize	0.621	0.595	-0.230	0.420	0.395	0.484	0.484	0.383	0.349	-0.030	-0.042	-0.164	0.749	0.441	0.572	0.166	0.272	0.435	0.289	0.600	1.000				
47 Metal ores(UK)	0.397	0.208	0.004	0.196	0.266	0.686	0.351	0.228	0.291	0.011	0.138	-0.090	0.558	0.120	0.187	0.067	0.014	0.370	0.001	0.452	0.413	1.000			
48 Metals (UK)	0.834	0.776	0.103	0.427	0.731	0.300	0.513	0.725	0.524	0.228	0.302	-0.203	0.817	0.405	0.571	0.124	0.322	0.105	0.163	0.674	0.594	0.501	1.000		
49 Ag Non-Foods	0.741	0.586	0.057	0.744	0.719	0.321	0.583	0.827	0.676	0.309	0.347	-0.174	0.758	0.538	0.690	0.226	0.426	0.148	0.305	0.670	0.607	0.517	0.831	1.000	
50 Foods	0.374	0.494	-0.520	0.089	-0.076	0.471	0.577	-0.003	-0.279	-0.243	-0.643	0.574	0.555	0.648	0.558	-0.604	-0.202	0.478	0.034	0.558	0.339	0.096	0.357	0.245	1.000

TABLE A6

CORRELATION OF CHANGES IN REAL PRICE INDICES ON A YEAR EARLIER (PERCENTAGE) 1974 I - 1980 IV

		1	2	3	4	5	6	7	8	9	10	11	12
1	Iron ore	1.000											
2	Steel scrap	-0.181	1.000										
3	Copper ore	0.262	0.546	1.000									
4	Nickel "	0.005	0.058	0.202	1.000								
5	Bauxite	0.604	-0.291	-0.388	-0.198	1.000							
6	Lead ore	0.282	0.526	0.536	-0.296	0.031	1.000						
7	Zinc "	0.208	0.499	0.372	-0.250	0.257	0.685	1.000					
8	Tin "	0.187	-0.012	0.395	-0.039	0.093	0.278	0.333	1.000				
9	Manganese ore	0.373	0.317	-0.019	-0.295	0.372	0.725	0.639	-0.015	1.000			
10	Chrome "	0.585	-0.444	-0.411	-0.398	0.895	-0.013	0.134	0.252	0.321	1.000		
11	Tungsten "	-0.341	0.310	-0.260	0.329	0.096	0.171	0.404	-0.065	0.363	-0.110	1.000	
12	Copper scrap	0.262	0.546	1.000	0.202	-0.388	0.536	0.372	0.395	-0.019	-0.411	-0.260	1.000
13	Nickel "	0.005	0.058	0.202	1.000	-0.198	-0.296	-0.250	-0.039	-0.295	-0.398	0.329	0.202
14	Aluminium "	-0.090	0.592	0.786	0.244	-0.395	0.566	0.582	0.541	0.007	-0.455	0.233	0.786
15	Manganese "	0.373	0.317	-0.019	-0.295	0.372	0.725	0.639	-0.015	1.000	0.321	0.363	-0.019
16	Lead "	-0.063	0.643	0.807	0.371	-0.412	0.396	0.385	0.334	-0.142	-0.560	0.053	0.807
17	Zinc "	0.117	0.859	0.717	0.133	-0.273	0.588	0.470	-0.096	0.306	-0.457	0.072	0.717
18	Tin "	-0.480	0.142	0.062	-0.130	-0.486	-0.250	-0.253	-0.250	-0.478	-0.448	-0.324	0.062
19	Ir & st sheets	-0.173	-0.412	-0.404	0.278	0.289	-0.403	-0.139	0.412	-0.300	0.293	0.312	-0.404
20	Ir & st bars	-0.142	-0.298	-0.062	-0.058	0.156	0.016	0.271	0.646	-0.218	0.253	0.202	-0.062
21	I & s fe alloys	0.027	-0.005	-0.573	0.202	0.488	-0.294	-0.112	-0.496	0.228	0.258	0.406	-0.575
22	Copper	0.230	0.575	0.960	0.304	-0.436	0.561	0.381	0.214	0.048	-0.512	-0.131	0.960
23	Nickel	0.630	-0.293	0.167	0.540	0.334	-0.063	-0.051	0.188	-0.005	0.258	-0.040	0.167
24	Aluminium	-0.389	-0.263	-0.425	0.357	-0.227	-0.255	-0.242	-0.396	-0.065	-0.293	0.489	-0.425
25	Lead	-0.117	0.477	0.596	0.509	-0.364	0.226	0.265	-0.101	-0.228	-0.631	0.177	0.596
26	Zinc	0.229	0.759	0.689	-0.125	-0.187	0.814	0.630	-0.027	0.525	-0.396	0.015	0.689
27	Tin	-0.344	0.674	0.357	0.123	-0.432	0.554	0.548	-0.180	0.304	-0.579	0.553	0.357
28	Hide	0.095	0.029	0.530	-0.045	-0.033	0.150	0.210	0.708	-0.363	0.053	-0.292	0.530
29	Soya beans	-0.175	0.271	0.250	0.399	-0.230	0.214	0.198	-0.116	0.035	-0.479	0.385	0.250
30	Rubber	0.214	0.405	0.884	0.067	-0.381	0.632	0.497	0.452	0.043	-0.381	-0.184	0.864
31	Wood pulp	0.339	0.418	-0.066	0.202	0.422	0.142	0.184	-0.385	0.514	0.165	0.309	-0.066
32	Hard wood	0.341	0.066	0.437	0.187	-0.531	0.332	0.026	-0.085	0.202	-0.345	-0.188	0.437
33	Lumber	-0.018	0.225	0.705	0.275	-0.456	0.395	0.327	0.390	-0.192	-0.523	0.010	0.705
34	Cotton	0.327	0.351	0.712	0.041	-0.164	0.653	0.499	0.506	0.284	-0.156	-0.012	0.712
35	Wool 64s	0.139	-0.284	0.486	0.367	-0.435	-0.081	-0.252	0.299	-0.464	-0.311	-0.344	0.486
36	Wool 50s	0.151	-0.054	0.617	0.285	-0.266	0.206	0.167	0.663	-0.289	-0.174	-0.104	0.617
37	Jute	-0.661	-0.002	-0.665	-0.079	-0.110	-0.455	-0.350	-0.432	-0.126	-0.145	0.268	-0.665
38	Sisal	-0.048	0.713	0.420	0.383	-0.306	0.428	0.349	-0.316	0.316	-0.576	0.399	0.420
39	Lard	-0.093	0.543	-0.011	-0.133	0.074	0.256	0.270	-0.543	0.240	-0.240	0.127	-0.011
40	Soya oil	-0.263	0.585	0.122	0.022	-0.197	0.393	0.362	-0.464	0.357	-0.497	0.426	0.122
41	Coffee	0.048	-0.075	0.230	0.366	0.037	0.302	0.457	0.444	0.039	-0.055	0.460	0.230
42	Cocoa	-0.290	0.110	0.110	0.312	-0.196	0.297	0.428	0.119	0.055	-0.363	0.632	0.110
43	Sugar	0.077	0.259	-0.131	0.235	-0.065	-0.044	-0.186	-0.388	0.426	-0.126	0.212	-0.131
44	Tea	-0.213	-0.073	-0.127	0.322	-0.002	0.128	0.239	-0.099	0.105	-0.207	0.638	-0.127
45	Wheat	0.312	0.650	0.645	-0.064	-0.175	0.556	0.320	-0.098	0.359	-0.294	-0.297	0.645
46	Maize	0.234	0.383	0.460	0.313	-0.107	0.630	0.500	0.059	0.497	-0.289	0.286	0.460
47	Metal ores(UK)	0.533	0.172	0.622	0.565	0.134	0.283	0.300	0.646	0.073	0.067	0.076	0.622
48	Metals (£K)	0.120	0.542	0.886	0.279	-0.427	0.632	0.524	0.253	0.080	-0.510	0.057	0.886
49	Ag Non Foods	0.168	0.452	0.780	0.408	-0.345	0.493	0.373	0.156	0.042	-0.531	0.083	0.780
50	Foods	-0.068	0.032	0.008	-0.184	-0.280	0.139	-0.062	-0.438	0.108	-0.284	-0.214	0.008

		13	14	15	16	17	18	19	20	21	22	23	24	25
13	Nickel "	1.000												
14	Aluminium "	0.244	1.000											
15	Manganese "	-0.295	0.007	1.000										
16	Lead "	0.371	0.845	-0.142	1.000									
17	Zinc "	0.133	0.552	0.306	0.724	1.000								
18	Tin "	-0.130	-0.012	-0.478	0.228	0.178	1.000							
19	Ir & st sheets	0.278	-0.035	-0.300	-0.130	-0.606	-0.118	1.000						
20	Ir & st bars	-0.058	0.295	-0.218	0.056	-0.406	-0.037	0.698	1.000					
21	I & s fe alloys	0.202	-0.508	0.228	-0.361	-0.053	-0.108	0.101	-0.337	1.000				
22	Copper	0.304	0.770	0.048	0.803	0.771	0.024	-0.488	-0.191	-0.467	1.000			
23	Nickel	0.540	0.038	-0.005	0.047	-0.028	-0.315	0.214	0.082	0.092	0.176	1.000		
24	Aluminium	0.357	-0.191	-0.065	-0.206	-0.220	0.045	0.229	0.046	0.183	-0.276	0.093	1.000	
25	Lead	0.509	0.599	-0.228	0.800	0.637	0.238	-0.170	-0.081	-0.148	0.696	0.049	0.093	1.000
26	Zinc	-0.125	0.520	0.525	0.561	0.872	-0.056	-0.682	-0.399	-0.174	0.754	-0.198	-0.341	0.470
27	Tin	0.123	0.571	0.304	0.501	0.638	0.157	-0.300	-0.057	-0.115	0.501	-0.281	0.317	0.613
28	Hide	-0.045	0.498	-0.363	0.452	0.061	0.01[illegible]	0.186	0.559	-0.606	0.360	0.078	-0.421	0.293
29	Soya beans	0.399	0.393	0.035	0.387	0.261	-0.33[illegible]	-0.092	-0.112	-0.136	0.362	-0.078	0.226	0.553
30	Rubber	0.067	0.829	0.043	0.745	0.544	-0.043	-0.319	0.076	-0.698	0.860	0.107	-0.359	0.525
31	Wood pulp	0.202	-0.203	0.514	-0.022	0.462	-0.173	-0.253	-0.536	0.776	0.033	0.201	-0.096	0.078
32	Hard wood	0.187	0.238	0.202	0.235	0.344	-0.098	-0.404	-0.428	-0.271	0.530	0.358	0.157	0.169
33	Lumber	0.275	0.811	-0.192	0.709	0.340	-0.037	-0.061	0.265	-0.679	0.710	0.152	-0.026	0.618
34	Cotton	0.041	0.716	0.284	0.517	0.394	-0.480	-0.273	0.000	-0.577	0.702	0.117	-0.345	0.265
35	Wool 64s	0.367	0.364	-0.464	0.300	-0.063	-0.046	0.040	0.221	-0.725	0.463	0.209	0.129	0.294
36	Wool 50s	0.285	0.690	-0.288	0.496	0.021	-0.239	0.169	0.472	-0.732	0.559	0.[illegible]25	-0.158	0.344
37	Jute	-0.079	-0.482	-0.126	-0.316	-0.257	0.308	0.173	-0.158	0.508	-0.627	-0.[illegible]73	0.333	-0.204
38	Sisal	0.383	0.448	0.316	0.576	0.815	0.144	-0.408	-0.434	0.194	0.584	0.031	0.204	0.517
39	Lard	-0.133	-0.080	0.240	0.139	0.436	0.121	-0.420	-0.414	0.308	0.091	-0.[illegible]16	0.056	0.361
40	Soya oil	0.022	0.214	0.357	0.269	0.569	0.009	-0.438	-0.409	0.199	0.264	-0.[illegible]63	0.190	0.434
41	Coffee	0.366	0.598	0.039	0.309	-0.092	-0.461	0.377	0.575	-0.298	0.266	0.[illegible]19	0.165	0.327
42	Cocoa	0.312	0.531	0.[illegible]75	0.329	0.032	-0.319	0.213	0.390	-0.191	0.228	-0.090	0.356	0.488
43	Sugar	0.235	-0.259	0.426	-0.207	0.242	-0.053	-0.313	-0.621	0.452	-0.0[illegible]8	0.166	0.200	-0.217
44	Tea	0.322	0.198	0.105	0.035	-0.078	-0.388	0.213	0.263	0.020	-0.005	0.030	0.6[illegible]2	0.313
45	Wheat	-0.064	0.308	0.359	0.496	0.815	0.176	-0.682	-0.592	-0.081	0.660	-0.013	-0.45[illegible]	0.339
46	Maize	0.313	0.428	0.497	0.404	0.526	-0.143	-0.176	-0.073	-0.146	0.556	0.[illegible]49	0.[illegible]57	0.434
47	Metal ores(UK)	0.565	0.580	0.073	0.540	0.287	-0.414	0.208	0.238	-0.203	0.569	0.[illegible]48	-0.2[illegible]	0.324
48	Metals (£K)	0.279	0.843	0.080	0.814	0.724	0.045	-0.340	0.066	-0.520	0.933	0.139	-0.083	0.752
49	Ag Non Foods	0.408	0.743	0.042	0.733	0.608	-0.211	-0.313	-0.113	-0.445	0.845	0.221	-0.07[illegible]	0.723
50	Foods	-0.184	-0.209	0.108	-0.023	0.267	0.496	-0.353	-0.293	-0.064	0.059	-0.102	0.[illegible]19	0.117

TABLE A6 (continued)

CORRELATION OF CHANGES IN REAL PRICE INDICES ON A YEAR EARLIER (PERCENTAGE) 1974 I - 1980 IV

	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
1 Iron ore																									
2 Steel scrap																									
3 Copper ore																									
4 Nickel "																									
5 Bauxite																									
6 Lead ore																									
7 Zinc "																									
8 Tin "																									
9 Manganese ore																									
10 Chrome "																									
11 Tungsten "																									
12 Copper scrap																									
13 Nickel "																									
14 Aluminium "																									
15 Manganese "																									
16 Lead "																									
17 Zinc "																									
18 Tin "																									
19 Ir & st sheets																									
20 Ir & st bars																									
21 I & s fe alloys																									
22 Copper																									
23 Nickel																									
24 Aluminium																									
25 Lead																									
26 Zinc	1.000																								
27 Tin	0.623	1.000																							
28 Hide	0.044	-0.123	1.000																						
29 Soya beans	0.299	0.407	0.065	1.000																					
30 Rubber	0.636	0.373	0.513	0.742	1.000																				
31 Wood pulp	0.355	0.146	-0.476	-0.081	-0.286	1.000																			
32 Hard wood	0.410	0.193	-0.227	0.146	0.516	0.023	1.000																		
33 Lumber	0.349	0.364	0.523	0.540	0.847	-0.445	0.455	1.000																	
34 Cotton	0.588	0.240	0.413	0.476	0.846	-0.177	0.485	0.738	1.000																
35 Wool 64s	-0.103	-0.074	0.481	0.267	0.527	-0.624	0.431	0.693	0.443	1.000															
36 Wool 50s	0.056	0.050	0.718	0.299	0.715	-0.567	0.245	0.827	0.702	0.822	1.000														
37 Jute	-0.332	-0.018	-0.434	-0.042	-0.643	0.098	-0.452	-0.564	-0.649	-0.586	-0.686	1.000													
38 Sisal	0.658	0.745	-0.328	0.347	0.314	0.538	0.469	0.293	0.211	-0.109	-0.102	-0.095	1.000												
39 Lard	0.464	[illegible]	-0.256	0.496	-0.011	0.364	-0.017	-0.045	-0.069	-0.407	-0.472	0.266	0.435	1.000											
40 Soya oil	0.592	0.667	-0.351	0.653	0.133	0.358	0.153	0.162	0.166	-0.314	-0.304	0.201	0.683	0.844	1.000										
41 Coffee	-0.021	0.243	0.331	0.530	0.442	-0.320	0.052	0.642	0.522	0.427	0.690	-0.446	0.034	-0.164	0.028	1.000									
42 Cocoa	0.138	0.547	0.116	0.712	0.347	-0.246	0.030	0.603	0.400	0.225	0.441	-0.081	0.238	0.165	0.412	0.810	1.000								
43 Sugar	0.116	0.121	-0.682	-0.080	-0.296	0.614	0.265	-0.423	-0.171	-0.308	-0.502	0.197	0.442	0.091	0.275	-0.372	-0.320	1.000							
44 Tea	-0.035	0.429	-0.085	0.723	-0.010	-0.116	-0.10	0.316	0.139	0.157	0.171	-0.002	0.191	0.314	0.482	0.649	0.804	-0.111	1.000						
45 Wheat	0.827	0.303	-0.025	0.121	0.515	0.420	0.447	0.191	0.398	-0.100	-0.097	-0.271	0.599	0.462	0.456	-0.291	-0.258	0.325	-0.352	1.000					
46 Maize	0.532	0.529	0.006	0.404	0.464	0.241	0.473	0.439	0.422	0.175	0.203	-0.383	0.600	0.254	0.403	0.343	0.322	0.278	0.306	0.506	1.000				
47 Metal ores (UK)	0.215	0.009	0.460	0.169	0.534	0.112	0.246	0.463	0.568	0.417	0.636	-0.627	0.184	-0.342	-0.228	0.510	0.182	-0.019	0.059	0.194	0.448	1.000			
48 Metals (UK)	0.702	0.662	0.393	0.404	0.841	-0.079	0.441	0.779	0.650	0.476	0.601	-0.610	0.593	0.094	0.299	0.439	0.430	-0.167	0.208	0.492	0.604	0.537	1.000		
49 Ag Non Foods	0.608	0.465	0.335	0.729	0.816	-0.053	0.521	0.859	0.792	0.540	0.633	-0.565	0.541	0.238	0.440	0.530	0.536	-0.112	0.357	0.477	0.613	0.540	0.827	1.000	
50 Foods	0.230	0.327	-0.304	-0.124	-0.022	0.021	0.391	-0.092	-0.285	-0.020	-0.398	0.162	0.317	0.379	0.269	-0.431	-0.242	0.229	-0.022	0.337	0.321	-0.348	0.126	[illegible]	1.000

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Short-run pricing behaviour in commodity markets

by

C A Enoch

Contents

1

Introduction

1 This note extends to commodity markets a stability test that has been previously applied to the foreign exchange market.[1] In that study daily exchange rate and other data over successive periods in 1976 were used to examine whether the foreign exchange market was, in a particular sense, 'unstable'. In this note a similar test is carried out on prices in the markets for copper, tin, cocoa and sugar using daily price data over successive periods in 1979 and early 1980.

2 The importance of this subject is clear: changes in commodity prices have a direct impact on the incomes of many countries, and excessive price fluctuations are often put forward as a reason for commodity price stabilisation schemes. If it could be demonstrated that commodity markets, at least over particular periods, are unstable, then this would provide a strong argument in favour of such schemes.[2]

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[1] W A Allen and C A Enoch (1978).

[2] Note, however, that a failure to find that markets are unstable does not per se constitute an argument against commodity price stabilisation schemes. On the other hand, one qualification to this argument is that its validity requires that observed market behaviour actually reflects that of private agents. It could be argued that any observed instability is due instead to the behaviour of the authorities - either actual or perceived - and not the private agents. For instance, price stabilisation schemes themselves might destabilise the markets. Furthermore, the threat of the disposal of the US stockpile of, for example, tin certainly also has an effect on private traders' behaviour. The interaction between commodity markets and stabilisation schemes has been analysed by Newbery and Stiglitz. See, for instance, D M G Newbery and J E Stiglitz (1978 and 1979).

A model of commodity markets

3 This section describes a general model of commodity markets, distinguishing spot and futures markets. A commodity market is defined to consist of speculators, arbitrageurs and hedgers. Speculators take up open positions in the futures market, reacting to a difference between the futures price for a commodity and the spot price expected to prevail when the futures contract matures.[1] Arbitrageurs cover their positions; they react to the difference between interest rates on financial assets for a certain maturity and the premium or discount on the spot price of a commodity against a futures contract of the commodity for that maturity.[2] Additionally, Working[3] suggested that arbitrageurs' decisions in commodity markets will be related to the price of storage, and that future price premia or discounts will therefore reflect also the price of storage. Hedgers have claims on, or liabilities against, future delivery of the commodity and cover them in the futures market regardless of their expectations (if any) about the future path of the price of the commodity. It is assumed that the weight of pure hedging in this sense is roughly constant over time, in which case the behaviour of hedgers can be excluded from the following analysis; this assumption is more likely to be valid for commodities whose production is non-seasonal, like the metals considered here, and should be borne in mind when results are discussed for the seasonal commodities.[4]

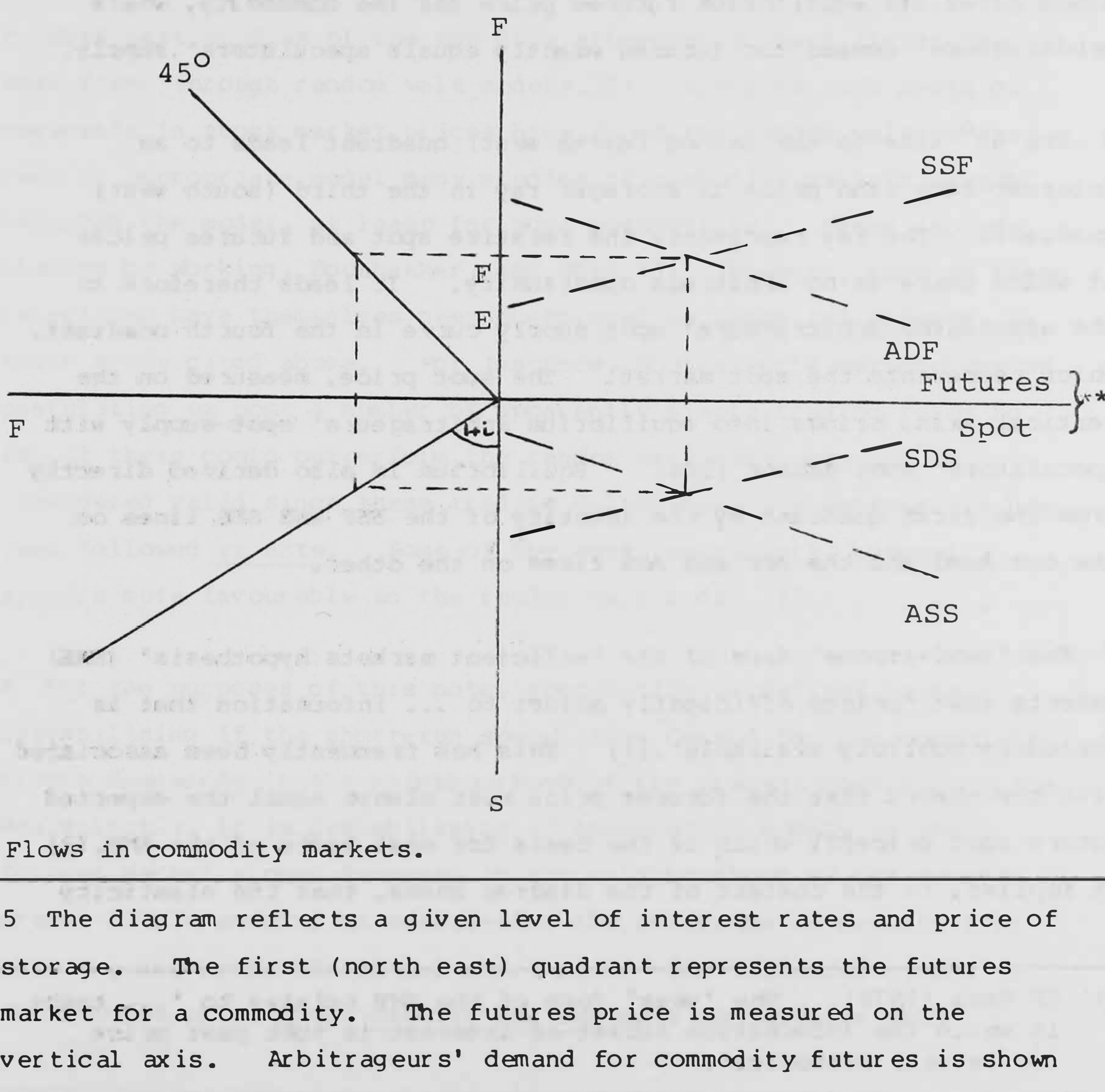
[1] This is a simplification since many, if not most, speculators would not expect to hold the futures contract until maturity.

[2] 'Arbitrageurs' in commodities markets clearly do not fulfil exactly the same role as in the foreign exchange markets. In foreign exchange markets, arbitrageurs move between assets of the same maturity denominated in different currencies if the interest differential between these assets deviates from the forward premium/discount. Here the commodity itself yields no interest so that the interest rate on available financial assets is equated to the futures premium/discount. The existence of 'margin' requirements complicates the analysis, but is ignored for the purposes of this note.

[3] H Working (1949 and 1953).

[4] It is possible that the quantity of hedging may not be constant even for non-seasonal commodities and even over the very short periods under examination here. First, a sudden large change in prices may make more traders aware of the possible benefits of hedging; and second, a certain minimum level of (expected) price volatility is required in order for the beneits of hedging to exceed the transactions costs.

4 Excluding hedgers, the only agents in the futures market are speculators and arbitrageurs, so their holdings of futures contracts of a commodity must sum to zero. Since arbitrageurs' forward positions are exactly the reverse of their spot positions, speculators' net liabilities in the futures markets of the commodity must equal arbitrageurs' net liabilities in the spot market of the commodity. This can be illustrated in the following diagram:



* Flows in commodity markets.

5 The diagram reflects a given level of interest rates and price of storage. The first (north east) quadrant represents the futures market for a commodity. The futures price is measured on the vertical axis. Arbitrageurs' demand for commodity futures is shown by the ADF line. Where it cuts the vertical axis, the rate of interest on financial assets exactly equals the difference between the spot and futures price of the commodity (allowing for price of storage) and there is no arbitrage opportunity. Reductions in the futures price may be expected to induce arbitrageurs to operate in larger amounts, or may perhaps induce increasing numbers of people to become arbitrageurs. The ADF line is therefore drawn sloping

downwards (although if arbitrage were perfect the line would be horizontal). The SSF line represents futures supply by speculators; its intercept with the vertical axis indicates the expected future spot price. At this point, where the futures price equals the expected future spot price, there will be no incentive for net speculative activity. The higher the futures price above this point, the greater the incentive for speculators to supply futures contracts, and so the SSF line will slope upwards. The intersection of the SSF and ADF lines gives the equilibrium futures price for the commodity, where arbitrageurs' demand for futures exactly equals speculators' supply.

6 The 45^{o} line in the second (north west) quadrant leads to an interest-rate (and price of storage) ray in the third (south west) quadrant. The ray represents the relative spot and futures prices at which there is no arbitrage opportunity. It leads therefore to the associated arbitrageurs' spot supply curve in the fourth quadrant, which represents the spot market. The spot price, measured on the vertical axis, brings into equilibrium arbitrageurs' spot supply with speculators' spot demand (SDS). Equilibrium is also derived directly from the first quadrant by the identity of the SSF and SDS lines on the one hand and the ADF and ASS lines on the other.

7 The 'semi-strong' form of the 'efficient markets hypothesis' (EMH) asserts that 'prices efficiently adjust to ... information that is obviously publicly available'.[1] This has frequently been associated with the theory that the futures price must always equal the expected future spot price[2] which is the basis for most tests of the EMH.[3] It implies, in the context of the diagram above, that the elasticity

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[1] EF Fama (1970). The 'weak' form of the EMH relates to '... tests in which the information subset of interest is just past price (or return) histories'.

[2] For instance W C Labys and C W J Granger (1970).

[3] Labys and Granger (1970) point out (page 90) that 'the theory of expectations as applied to commodity prices would lead one to hypothesise that futures prices represent an expected or unbiased estimate of cash prices. If the risk premium paid to speculators were included, it would stipulate that futures prices are biased estimates of cash prices.' They themselves choose the 'unbiased version' as the basis for the formal model they present, feeling that it is in this version that the interesting implications of the theory lie.

of speculative funds is infinite and the SSF line horizontal. If even risky speculative profit opportunities are eliminated by the market, then it is reasonable to suppose that riskless arbitrage opportunities are also eliminated, and that the ADF line is horizontal and coincides with the SSF line.[1] If the EMH holds in this form intervention in the markets by the authorities will be unable to influence the price in the market and so a policy intending to do so could not be successful.

8 Most past studies of the EMH have attempted to test it (in the weak form) through random walk models.[2] Although such tests of movements in stock market prices have found the random walk to have been an appropriate model many studies of commodity markets have rejected the model, at least for some commodities. These include studies by Working, Houthakker, and Goss.[3] However, some of these rejections have themselves been questioned by Labys and Granger, in their study cited above. For instance, Houthakker's methodology of postulating ex post a number of apparently simple trading rules to see if these could outperform the random walk model may not be considered valid since these trading rules would not necessarily have been followed ex ante. Some of the more recent work, however, appears more favourable to the random walk model.[4]

9 For the purposes of this note, speculation is defined to be destabilising if the short-run speculative demand for the commodity slopes downwards in the neighbourhood of the present commodity price. Equivalently, it is destabilising if speculative supply in the futures market slopes downward in the neighbourhood of the futures price. This amounts to postulating the existence of expectations that are extrapolative in the short run. For instance, a fall in the futures price would ceteris paribus make speculators with

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[1] If the ADF line and SSF line coincide, this implies that there is no model solution since the quantity traded in any period is indeterminate.

[2] See Fama (1970) page 388.

[3] H Working (1962), H S Houthakker (1961) and B A Goss (1981). Goss found that the random walk model explained movements in copper, tin, and zinc prices, but rejected it for movements in lead prices.

[4] Recent work is surveyed in D E Giles and B A Goss (1980).

regressive expectations less likely to believe that this futures price was above the future spot price and they would therefore be less likely to sell on the futures market. If, however, their expectations were extrapolative they might expect the future spot price to fall even further and might therefore increase speculative supply.[1] Moreover, if such extrapolative expectations are found this provides a refutation of EMH, at least in the form outlined above;[2] however, a demonstration that expectations are not extrapolative does not imply a necessary acceptance of the EMH.

10 The model outlined above of the futures price determination of a commodity can be presented as follows:

$$F = aS(1+i) + (1-a)E \qquad (1)$$

where F = futures price;

E = expected future spot price;

S = actual spot price;

i = interest rate;

and a and (1-a) are the weights mentioned above to be applied to arbitrage and speculation in determining the futures price. It is assumed that a is constant, which means that within each period the relative importance of arbitrage and speculative activity was constant. Although the shortness of the periods may give some plausibility to this assumption, it still is justified largely on grounds of necessity rather than intrinsic desirability. The price of storage could have been included within the first parenthesis,

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[1] This situation would not necessarily under all circumstances lead to instability in the sense that an initial disturbance taking the market away from equilibrium would generate continuing price/quantity cycles. For instance, in terms of the diagram on page 53, if the SSF line sloped downwards but the ADF line had an even steeper downward slope, the market would still be stable. However, it seems highly unlikely that there would be any sizeable slope to the ADF line and so this is unlikely to represent a major qualification to the definition above.

[2] It is logically possible that F = E, in the notation of the diagram above, and that expectations appear extrapolative if newly-received information systematically impinges more on events in the future than in the present. It is therefore necessary to assume that within the very short data periods under examination here this is not the predominant form of information received.

but has been excluded on grounds of absence of data and assumed constancy over time.

11 Rearranging this equation:

$$(F-S)/S = ai + (1-a)\left(\frac{E-S}{S}\right)$$

If FP is the premium on the future price of the commodity [= (F-S)/S] then:

$$\Delta FP = a\Delta i + (1-a)[(\Delta E/E)-(\Delta S/S)](E/S) \qquad (2)$$

The expected future spot rate E can be expressed as

$$E = bS + (1-b)E^* \qquad (3)$$

where E* reflects all influences on expectations not reflected in the current spot price. No attempt is made a priori to determine b, since this is not required for the empirical tests, but the untested assumption that it is constant is crucial. Substituting this into equation 2 yields:

$$\Delta FP = a\Delta i - (1-a)(1-b)[(\Delta S/S) - (\Delta E^*/S)] \qquad (4)$$

assuming $E/S \simeq 1$. If the EMH as defined on page 54 is true, $\Delta E^*/S$ is serially uncorrelated,[1] and should not therefore introduce any distorting serial correlation into the residuals of any equation of the form:

$$\Delta FP = \alpha + \beta\Delta i + \gamma\Delta S/S \qquad (5)$$

---

[1] This assertion is generally held to be true for the financial markets where the EMH was developed. For commodity markets it may not be valid for all cases. Serial correlation may be observed if production is not continuous and there are significant holding costs - which may well cover the seasonal crops examined in this study, sugar and cocoa. Tomek and Gray distinguished between 'continuous' and 'non-continuous inventory' commodities, and found a differential performance between these two categories in the function of future markets as forward anticipators of subsequent spot prices. See W G Tomek and R W Gray (1970).

If the EMH is true, γ should be zero. A sufficient condition for this from equation 4 is that b equals unity. From equation 3, $b = 1$ is the necessary condition for the EMH, whilst extrapolative expectations would suggest $b > 1$. This translates in equation 5 to the conditions that $\gamma < 0$ implies regressive expectations whilst $\gamma > 0$ implies extrapolative expectations.

The test

12 Equation 5 was estimated on daily data for four commodity markets over the periods from June to September 1979 and from October 1979 to January 1980. These periods were chosen as being the most recent past at the time that the data were collected. The eight month period from June 1979 was split half way through so as to see whether price behaviour changed between the two periods. The earlier period saw relatively little net change in commodities prices after a period of quite rapid rises at the start of 1979. In the later period prices began rising again, especially towards the end, perhaps because of large increases in oil prices, the Soviet invasion of Afghanistan and spillover from speculation in the precious metals.

13 Copper, tin, sugar and cocoa were chosen as the four commodities to be examined and three months was chosen as the futures contract maturity. LME quotes as reported in the Financial Times were taken for copper and tin spot and three-month futures prices. Sugar and cocoa price series were more difficult to construct since futures contracts mature on a particular day of the month (e.g. the 'October contract' all falls due simultaneously); because of this, the contract closest to maturity and the contract three months longer were chosen, price quotes again taken from the Financial Times, and dummy variables inserted when there was a shift in the contract being used in the series. This method is clearly not entirely satisfactory, so the results for these commodities are much less reliable than for the others. All price quotes were taken in sterling; the three-month eurosterling rate was used as the interest rate variable, but - as reported below - use of this variable did not prove successful, possibly because one single variable is unable fully to pick up all arbitrage costs in commodity markets.

Results

14 Results for price movements of the four commodities over the two periods are shown in Table A. In all cases there was evidence of regressive expectations, since the coefficient on the change in the spot price was negative and significantly different from zero; it therefore does not bear out the semi-strong form of the EMH outlined above. In all cases the coefficients on the constant and on the interest rate variable were insignificantly different from zero. The absence of any significant interest rate effect suggests that the variable used may have been inappropriate or that the existence of margin requirements may lead to significant arbitrage costs that would not be picked up by any single interest rate variable.

An extension: the price of gold

15 It is sometimes suggested that speculation in the precious metals markets tends to spill over into other commodities. Increases in the prices of precious metals might be regarded as indicators of uncertainty about the future and might be expected to show themselves as increases in the future premia on other commodities.

16 The equations reported in Table A were therefore re-run using changes in the price of gold as an additional explanatory variable. These are shown in Table B. There may be a problem of simultaneous equation bias here if the price of gold is also affected by the price of the other commodities. Ignoring this, in general, the effect of changes in the gold price on the futures premium was positive but insignificant. However, in the copper market in the second period, the impact of the gold price on the future premium was highly significant, although not very large, indicating that a 20% rise in the price of gold would raise the future premium on copper by about 1%.

An alternative model

17 The above discussion has assumed that all shocks to a particular commodity occur in the spot market and that the futures market merely adjusts to developments in the spot market. Thus it is assumed that shocks to the spot market are exogenous and those to the futures market follow from those in the spot market. Although such a model may be appropriate for the foreign exchange market it is by no means certain that it is valid when modelling commodities.

18 Consider the case of tin. The world physical market for tin is located in Penang, Malaysia, where almost two thirds of the world's smelting is carried out. The LME futures price is related by arbitrage to the spot price set in Penang since it is always possible to shift the metal physically, within about two to three months, to the LME warehouses in Europe. A fall in tin supply will therefore lead initially to a rise in the Penang spot price and from this to the LME futures price and so to the LME spot price. Thus the Penang spot price can be considered the 'primary' price for tin, the LME futures price the 'secondary' price and the LME spot price will then move in response to moves in the futures price, rather than vice-versa.

19 On this basis, an increase in the futures price initially produces a rise in the futures premium. If expectations are regressive the LME spot rate will rise but not by as much as the rise in the futures rate: hence some increase in the future premium will be observed. If expectations are neither regressive nor extrapolative the spot price will rise by as much as the futures price and there will be no change in the futures premium. Then if expectations are extrapolative spot prices will tend to rise by more than the futures price, and the future premium will fall. The model assumes therefore that spot demand for a commodity to close out past commitments is independent of current movements in the futures premium/discount.

20 This model can be presented algebraically in a form analogous to that of Section 2. Then:

$$S = cF\ (1-i) + (1-c)\ E' \qquad (6)$$

where E' is the expected futures price, c and (1-c) are the weights to be applied to arbitrage and speculation respectively and the remaining symbols are as defined above.

$$\text{If} \quad E' = dF + (1-d)\ F^* \qquad (7)$$

$$\text{then } \Delta\left(\frac{S-F}{F}\right) = -\ c\Delta i + (1-c)(1-d)\left(\frac{\Delta F^*}{F^*} - \frac{\Delta F}{F}\right) \qquad (8)$$

and if the future premium is now defined:

$$FP' = (F-S)/F$$

$$\Delta\ FP' = c\Delta i + (1-c)(1-d)\ \frac{\Delta F}{F} \qquad (9)$$

This can then be estimated in the form, analogous to equation 5:

$$\Delta\ FP' = \alpha\ + \beta\Delta\ i\ + \gamma\Delta\ F/F \qquad (10)$$

where $\Delta F/F$ is the change in the futures price. Equation 10 was estimated over the two periods for the copper and tin markets, since the data are more satisfactory for these commodities, and the results are shown in Table C. Again, the test was extended to include also the influence of the price of gold, and the results from this test are shown in Table D.

21 For copper, this alternative model suggests, in contrast to the earlier result, that expectations were extrapolative in both periods. The coefficient on past changes in futures prices was in all cases negative and highly significant, implying that a rise in the futures price would tend to reduce the futures premium. The effect was not very large with a 10% increase in the futures price tending to result in a fall in the premium of no more than 1%. The coefficient on the gold price was in both periods positive and significant, implying that a rise in the price of gold increases the future premium. This last result would be the one expected using the standard model outlined earlier in the paper, but may be inconsistent with the assumptions

underpinning the model being examined here. None of the tin equations had any significant explanatory power; in the earlier period the coefficient on past movements in the futures price was negative (hence suggesting instability) but it was not significant at the 95% confidence level.

Conclusions

22 In only one market, copper, and for only one of the models presented is there any evidence for extrapolative expectations. It is reasonable to expect that, if any one of the commodities examined here is affected by extrapolative expectations, this is most likely to be copper, since market reports generally find a relatively high level of non-trade activity for this commodity, and regard it as the first area affected at times of high speculative activity by spillover from precious metals. However, the adequacy of the model that suggested the existence of extrapolative expectations is far from certain: it is not possible in a statistical sense to choose between the two models that were presented here. More investigation would be needed in the market as to whether it is a reasonable representation of how prices are determined.

TABLE A

Daily movements in the premium on commodities' futures prices

	Constant	Interest rate	Change in spot rate	$\bar{R}^2$	SE	RSS	DW
Commodity:							
June 1979-Sept. 1979							
Copper	.00002 (.05)	.00046 (1.45)	-.0741 (4.78)	.24	.00260	.00055	1.92
Tin	.00032 (.44)	-.00125 (1.59)	-.5908 (18.32)	.80	.00652	.00345	2.06
Sugar	.00105 (.71)	-.00265 (1.67)	-.4689 (4.62)	.21	.01324	.01428	2.42
Cocoa	.00011 (.62)	.00071 (.31)	-.2942 (2.58)	.05	.01902	.02910	2.14
Oct. 1979-Jan. 1980							
Copper	.00025 (.52)	-.00057 (.96)	-.1052 (5.69)	.28	.00435	.00155	2.11
Tin	.00035 (.46)	-.00010 (.07)	-.4845 (9.93)	.54	.00687	.00387	1.96
Sugar	.00037 (.29)	.00249 (1.64)	-1.440 (3.29)	.13	.00112	.01031	2.94
Cocoa	-.00029 (.45)	.00016 (.21)	-.1321 (2.47)	.06	.00571	.00267	3.15

TABLE B

Daily movements in the premium on commodities' futures prices including gold price as an explanatory factor

	Constant	Interest rate	Change in spot rate	Gold price	$\bar{R}^2$	SE	RSS	DW
Commodity:								
June 1979-Sept. 1979								
Copper	-.00007	.00037	-.0798	.0296	.26	.00281	.00053	1.91
	(.25)	(1.17)	(5.10)	(1.78)				
Tin	.0001	-.0014	-.6913	.0618	.80	.00647	.00335	2.10
	(.12)	(1.78)	(18.47)	(1.50)				
Sugar	.00088	-.00279	-.4838	.0571	.20	.01333	.01412	2.42
	(.58)	(1.74)	(4.64)	(.65)				
Cocoa	-.00021	.00056	-.2970	.0689	.05	.01904	.02905	2.15
	(.10)	(.24)	(2.60)	(.57)				
Oct. 1979-Jan. 1980								
Copper	.0000	-.00034	-.1296	.0476	.39	.00402	.00131	2.23
	(.9)	(.61)	(7.13)	(3.91)				
Tin	.00021	-.00002	-.4973	.0241	.54	.00685	.00380	1.99
	(.27)	(.02)	(9.98)	(1.20)				
Sugar	.00067	.00235	-1.396	-.0544	.15	.01108	.00995	2.96
	(.53)	(0.57)	(3.23)	(1.72)				
Cocoa	-.00033	.00018	-.1338	.0071	.06	.00574	.00266	3.14
	(.51)	(.23)	(2.75)	(.43)				

TABLE C

Daily movements in the premium on commodities' futures prices

	Constant	Interest rate	Change in futures price	$\bar{R}^2$	SE	RSS	DW
Commodity:							
June 1979-Sept. 1979							
Copper	-.00669	.00059	-.06380	.125	.00276	.00062	2.10
	(1.58)	(1.59)	(3.60)				
Tin	-.00008	.00104	-.32443	.004	.01705	.02346	1.92
	(.03)	(.04)	(1.49)				
Oct. 1979-Jan. 1980							
Copper	.00021	-.00074	-.07781	.133	.00470	.00182	2.16
	(.39)	(1.16)	(3.54)				
Tin	.00023	.00084	-.08104	.001	.01701	.62334	1.94
	(.19)	(.56)	(.70)				

TABLE D

Daily movements in the premium on commodities' futures prices including gold price as an explanatory factor

	Constant	Interest rate	Change in spot rate	Gold price	$\bar{R}^2$	SE	RSS	DW
Commodity:								
June 1979-Sept. 1979								
Copper	-.0001 (.027)	.00053 (.87)	-.10739 (4.70)	.04412 (3.17)	.22	.00447	.00162	2.26
Tin	.00655 (.24)	-.00059 (.25)	-.3343 (1.53)	.09050 (.81)	.01	.01704	.02329	1.94
Oct. 1979-Jan. 1980								
Copper	-.0001 (.027)	-.00053 (.87)	-.10739 (4.76)	.04412 (3.17)	.22	.00447	.00162	2.26
Tin	.00031 (.25)	.00087 (.54)	-.0686 (.57)	-.01352 (.41)	-.02	.01114	.00998	1.86

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