SHORT TERM VARIATIONS
in
COPPER PRICES

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1. Introduction

The physical demand for copper tends to change rather slowly. Fabricators respond only gradually to final demand variations, which themselves are fairly gradual. Physical supplies however can undergoe sudden major changes from time to time due to new mining operations, labour problems, political conditions and so on. Since demand is fairly inelastic, these variations give rise to considerable price instability.

To protect individual fabricators against the consequences of this over typical order periods, futures trading facilities have been developed. While this insures the position of the holder of any particular hedging contract, the overall effects of hedging and speculation on day to day price dynamics are far from clear. It is to explore these very short run variations that the following spectral and cross-spectral studies were made of the copper market on the London Metal Exchange (LME). Previous studies by Labys and Granger [2] and Labys, Rees and Elliot [3] have focused on longer-run monthly variations and did not consider the possible effects of some important changes in market structure which have taken place in the post-war era.

The results reported here are largely inconclusive and are of a preliminary character only. But even these would seem opportune in view of current concern over the instability of the London commodity markets [5].

The London Metal Exchange actually handles only a marginal fraction of all refined copper traded. However its prices have had important relationships with the main trading prices between the major producers and their customers (outside the socialist countries). Thus it is possible to distinguish several distinct market régimes which have obtained since the LME reopened in August 1953 (following the final lifting of war-time controls on the U.K. copper market), c.f.Stewardson [4].

Régime I (Before October 1961)

Many important producers used averages of the independently determined LME cash prices as a basis for their own prices.

Régime II (October 1961 to January 1964)

Producers intervened in the LME to stabilize the cash price around £ 234 stg, which was also used as a basis for their own prices.

Régime III (January 1964 to April 1966)

Producers lost control of the LME, whose prices moved independently upwards, while the producers set their own prices at lower stabler values.

Régime IV (April 1966 to June 1968)

Many important producers used averages of independently determined LME three months' sellers quotation as a basis for their own prices.

Régime V (After June 1968)

Many important producers switched back to averages of the independently determined LME cash prices as a basis for their own prices (c.f. Régime I).

2. Spectral Analysis of Daily Bash Prices

The computational approach adopted here was that which has become associated with the development of the "fast Fourier transform" [1]. This was not because of any claimed advantage with regard to the speed of calculation for these (comparatively short) series, but rather because of the intuitive simplicity of the procedure.

Thus, given all the (complex) Fourier coefficients $a(k) + i.b(k)$ of a finite discrete time series, spectral estimates are obtained as local averages of their squared moduli (periodogram values). This gives for the average

spectral estimate in the neighbourhood of frequency point n :

$$f(n) = \sum_{k=n-m}^{n+m} | a(k) + i \cdot b(k) |^2 / (2m+1)$$

Hence, if the time series data are normal and uncorrelated, so also are the coefficients of their finite discrete Fourier transform. Hence spectral estimates corresponding to sums of squared moduli of these will have a chi-square distribution. This gives a very powerful test for an independent normal sequence and hence for so-called random walk sequences (whose increments are uncorrelated over time) c.f. Granger and Labys [2].

The following results were obtained for detrended first differences of log transformed data.

Daily Cash Prices

Time Period	Market Regime	Spectrum Characteristics
September 1960 to September 1961	I (free market, followed by producers)	white noise
October 1961 to October 1962	II (producer intervention)	bluish noise
January 1964 to January 1965	III (free market, not followed by producers)	white noise

October 1966 to October 1967	IV (free market, producers following related 3 months forward prices)	white noise
June 1968 to June 1969	V (free market, followed by producers)	white noise

It should be observed that no weekly price "cycles" were found, and that only under Régime II were the spectra significantly different from white noise. In this case the regular producer "corrections" presumably caused the statistically significant element of negative autocorrelation.

3. Daily Forward Prices and their Relation to Cash Prices

Rather similar results were obtained for the spectra of forward prices (except that here no spectra differed significantly from the white noise case). However more interesting results were expected from the cross spectra of cash and forward prices (again in the form of detrended first differences of logarithms). These were also computed with the aid of a fast Fourier transform.

Thus similarly to our estimation of spectra as local averages of squared Fourier coefficients of individual time series, we estimated cross spectra as local averages of cross products of Fourier coefficients of different series. Specifically, for the average cross spectral estimate between series x (t) and y (t) in the neighbourhood of some frequency point n, we had :

$$f_{xy}(n) = \sum_{k=n-m}^{n+m} |a(k) + i.b(k)||A(k) - i.B(k)| / (2m+1)$$

The resulting coherences and phases are fairly well characterized by the average values shown in the following table.

Daily Cash and Forward Prices

Time Period	Average Coherences	Average Phase Difference
September 1960 to September 1961	.6	.25
October 1961 to October 1962	.4	.15
January 1964 to January 1965	.4	.10
October 1966 to October 1967	.4	.20
June 1968 to June 1969	.8	.02

It should also be observed that in all cases the coherences were higher and the phases closer to zero at the lower frequences. But nowhere were the phases significantly different from zero.

Thus it appears from these data that futures prices do not anticipate cash prices, even by one day, over the high frequency range being considered (1/32 to 1/2 cycles per day). However this does not refute an expectations model if we assume, as in the random walk model for cash prices, that todays prices give market operators their best prediction for tomorrows prices.

More generally it should be remembered that here we are studying just one reduced form equation of a whole structure of propensities reflecting the complex motivations (and information availabilities) of a number of classes of market operators. The high levels of coherence indicate however the workings of very consistent market forces.

4. Weekly Prices and the Effect of Market Conditions

Results similar to those described above were obtained when weekly data were used, as the following table indicates.

Weekly Cash and Forward Prices

Time Period	Cash Spectrum	Forward Spectrum	Avg.Coherence	Avg.Phase
Dec. 1965 to Oct.1970	white	white	0.8	0.1

One advantage of studying weekly figures is that in this case additional data are available for the state of the market, specifically for trading volumes and stocks. The effect of these variables on prices are as shown on the next page. As usual the variables are in detrended first difference of logarithms form.

Cross Spectra with Cash Mean

Weekly data Dec.1965 to Oct. 197o

Series 2	Spectrum 2	Average Coherence
stocks	white	o.15
Turnover	blue	o.1o

It can be seen that little coherence exists between weekly price changes and weekly trading volumes or stock levels (on the LME), and that consequently these reltionships are highly indeterminate. This seems to be an interesting result in view of occasional attempts by market observers to explain particular price changes in terms of LME stocks or turnover.

The negligible effect of stocks is not surprising in view of the manifestly small role of LME stock changes in any overall measure of excess supply for copper. However the uniformly low coherence between turnover and prices observed here might be taken to indicate that the volatile speculative turnover components (mainly high frequences) have no more consistent effect on price variators than the steadier (lower frequency)

physical demand turnover charges. Further work would seem to be indicated to clarify this inference and to test its applicability to other markets, and to other time periods.[1]

[1] I am indebted to Dr.Walter Labys for an interesting discussion on this point.

Abstract

Day-to-day and week-to week variations in copper prices on the London Metal Exchange are analysed by the methods of spectral and cross spectral analysis. Apart from a period of some 27 months in the early sixties (when producers intervened to stabilize cash prices), the random walk model gives a good explanation of short term price charges. In addition, although short term fluctuations in cash and futures prices are strongly correlated, the former are not anticipated by the latter. It also appears that LME stocks and turnover have no consistent relationship with price movements.

References

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| 5 | The Economist Business Report "A Commission on Commodities" The Economist, April 2o, 1974, pp 78 - 79.