Coal export prices

Leading economic indicators

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Leading economic indicators — constructed from historical lead–lag relationships between the price of a commodity and relevant economic variables — provide a guide to future movements in the commodity's price.

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Such leading economic indicators are used here for Australia's coal export prices. Using them may facilitate price discovery for the annual coal contract negotiations between Japan and Australia.

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The 21 month leading economic indicator suggests that the contract hard coking coal price in Japanese financial year 2002 may fall by around 1.7 per cent in real terms or rise by 0.8 per cent in nominal terms.

Australian coal exports

Coal is Australia's major commodity export and Japan continues to be Australia's most important coal export market. In 2000-01 Australia's black coal exports of 194 million tonnes were valued at A$10.8 billion (ABARE 2001). Japan accounted for nearly half of Australia's black coal exports in volume terms.

Australia's coking and thermal coal exports are mainly sold under contract, with price, quantity and quality specified for a period of one year. Typically, in the Asia Pacific regional market, contract prices are negotiated sequentially, by major importing country and by coal category. Coal price settlements are often first negotiated by Australia with Japanese steel mills for coking coal and subsequently with Japanese power utilities for thermal coal.

Since JFY1996 (Japanese fiscal year beginning April 1996), with the adoption of the 'fair treatment' pricing system, coal price and other contract details remain confidential. Although industry commentators, such as *Coal Week International* and the *International Coal Report*, publish estimates of contract price settlements, such confidentiality arrangements make coal price discovery during the annual negotiations difficult.

In a recent research project undertaken for the Department of Industry, Science and Resources, ABARE examined the possibility of constructing leading economic indicators for contract prices of Australian coal exports to Japan that may be updated and published on a regular basis.

Leading economic indicators are derived from economic variables that have a systematic leading relationship with prices over

some historical time period. Leading economic indicators for coal therefore provide signals of future movements in contract coal prices. Since leading economic indicators use updated market information, they may facilitate price discovery in the annual negotiations between Japan and the major coal exporting countries to that market.

The objectives in this article are:
- to present the four leading economic indicators for contract hard coking coal prices that were estimated by Hogan, Fainstein and Copeland (2001); and
- to examine the extent to which these indicators are relevant to other coal export prices.

Some examples of leading indicators

Although more sophisticated modeling techniques are available, the leading indicators approach is applied because policy makers and market analysts have found it to be a useful short run forecasting tool. The main application has been for business cycle analysis. Business cycles are medium term fluctuations in aggregate economic activity that are often sourced in a single major country or group of countries and have impacts on the world economy. Business cycles are an observed phenomenon. Although the term 'cycle' implies some regularity, business cycles vary in intensity and duration.

Some examples of the use of leading economic indicators are as follows.
- In *Survey of Current Business*, the US government publishes a composite index of leading indicators that is widely reported, particularly in periods close to turning points, because it has provided useful signals of short run changes in aggregate economic activity.
- In *Main Economic Indicators*, the OECD publishes leading economic indicators of industrial production in member countries.
- In *Metal Industry Indicators*, the US Geological Survey publishes leading indexes of metal prices and activity in the primary metals industry. That organisation's leading index of metal prices since July 1994 is presented in Waring, Hogan and Tulpulé (2001).

The assessment undertaken by Hogan, Fainstein and Copeland (2001) suggests that the leading indicators approach may also prove to be useful for coal prices. This is not surprising since medium term fluctuations in coal prices are likely to be closely linked to the business cycle through demand side impacts.

Leading indicators approach

The leading indicators approach is based on the assumption that, in general, a time series may be decomposed into:
- a long term trend component,
- medium term cyclical fluctuations,
- within year seasonal changes and
- short term irregular movements.

Using the terminology of the leading indicators approach, the *reference series* refers to the target economic variable — in this case, coal price — around which leading indicators are constructed. The *cycles* of the reference series are compared with those of individual — and subsequently composite — indicator series. Ideally, the cyclical movements of a leading indicator should be similar to, and consistently lead, those of the reference series.

Terms often used to describe the cycle of a time series, and the relationship between the reference series and leading indicators, are explained in box 1.

Reference coal price series
Selected contract prices of Australia's coal exports to Japan are presented in figure A.

A Australia's coal exports to Japan
Selected contract prices
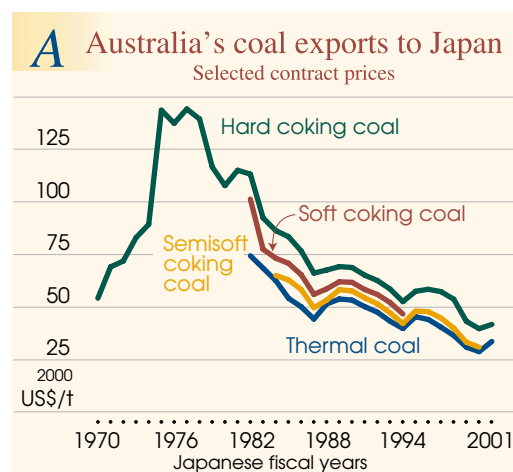
1   Cycles, reference series and leading indicators

In figure 1, a simple graphical approach is used to explain the main terms that describe the cycle of a time series:
- a turning point is either a peak or trough;
- a cycle is the time period between two peaks or two troughs;
- for cycles to be well defined, peaks and troughs must alternate;
- a phase is the time period between two consecutive turning points (that is, a peak and a trough, or a trough and a peak);
- the strength (or amplitude) of each peak or trough, and the time period (or duration) of each phase and cycle may vary.

The relationship between the cycles of a hypothetical reference series and an ideal leading indicator is presented in figure 2. In practice, leading indicators are not as reliable in signaling future changes in the reference series as indicated in the figure.

Consistent with the approach taken in Hogan, Fainstein and Copeland (2001), the cycle of each series in figures 1 and 2 is defined as a multiplicative relationship with the trend.
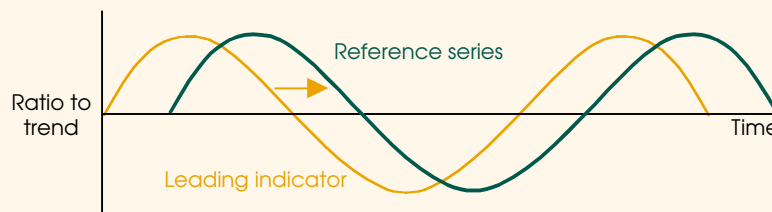
In this case, a cyclical component:
- equal to 1.0 implies the economic variable is on its trend in the corresponding time period;

1. Cycle of a time series
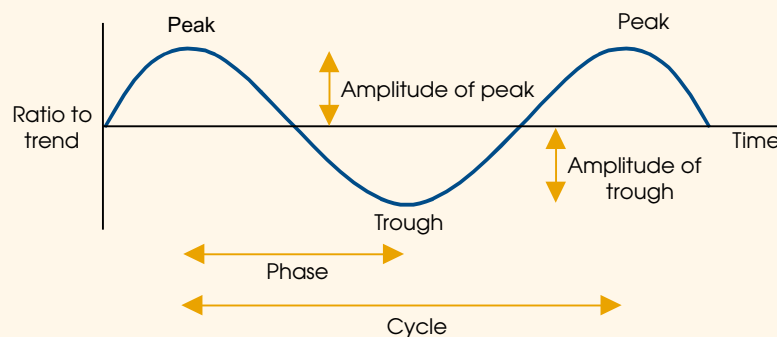
2. Reference series and leading indicators

In the leading indicators approach, the reference series is the target economic variable around which leading indicators are constructed. In the current study, the reference series is the contract price of Australia's hard coking coal exports to Japan. Ideally, the cyclical movements of a leading indicator should be similar to, and consistently lead, those of the reference series.

- greater than 1.0 implies the economic variable is above its trend; and
- less than 1.0 implies the economic variable is below its trend.

In each of these situations, the trend rate of growth in the economic variable may be positive, negative or zero. The cyclical component therefore does not indicate the absolute rate of growth in the economic variable.

In 2000 US dollars, the contract hard coking coal price nearly tripled from US$54 a tonne in JFY1970 to a peak of US$144 a tonne in JFY1977, and has since declined to US$42 in JFY2001. Other coal categories include soft coking coal, semihard coking coal (not included in figure A but data are available in ABARE 2000), semisoft coking coal and thermal coal. These coal categories receive a price discount relative to hard coking coal, largely reflecting lower coal quality.

Two coal categories have been reclassified over time. The soft coking coal category was merged with the semisoft coking coal category after JFY1994. In the latest annual negotiations, the semihard coking coal category has been reclassified as hard coking coal effective in JFY2001.

The contract hard coking coal price is chosen to be the reference series in the leading indicators analysis because:

- a relatively long time series is available for contract hard coking coal prices;
- hard coking coal prices are the first to be negotiated each year in Japan; and
- there is a strong relationship between contract hard coking coal prices and the contract prices of lower quality coal.

Since the time series for hard coking coal prices is annual data, for simplicity it is assumed that it excludes seasonal and irregular fluctuations.

The trend component of the hard coking coal price series is estimated using a smoothing technique (specifically, using the Hodrick-Prescott filter that is available in the software package Microfit 4.0; see Pesaran and Pesaran 1997).

The cyclical component is calculated by dividing the original series by the estimated trend. This cyclical component is often referred to as the ratio to trend. A value of 1.0 implies the economic variable (in this case, the contract hard coking coal price) is equal to its trend value in that time period; an observation above 1.0 implies the variable is above its trend; and, conversely, an observation below 1.0 implies the variable is below its trend.

Individual and composite indicators

Several individual economic variables were examined as possible leading indicators of the reference coal price, either as individual indicators or for inclusion in a composite of indicators.

In leading indicators analysis, aggregates or composites of individual leading indicators are typically constructed and assessed against the accuracy of individual series in signaling changes in the reference series. Composites are often found to be more reliable leading indicators since they summarise the cyclical components of two or more relevant economic variables.

Economic variables were initially considered if weekly or monthly data were available on a relatively timely basis, and if they were regarded as being a possible source of, or associated with, medium term fluctuations in contract coal prices.

The final set of economic variables is grouped to provide a signal of:

- the latest developments in coal spot markets (spot coal prices);
- the latest developments in other commodity spot markets (spot oil and other commodity prices);
- demand side influences (industrial production in Japan); and
- supply side indicators (Australia's export coal stocks).

In each case, individual economic indicators were constructed using monthly data. The final observation included in the analysis is December 2000. The seasonal and irregular components of each time series was removed from each series by smoothing the data (specifically, by taking a centred thirteen period moving average with asymmetric weights applied to extrapolate the series to the end of the original series).

The trend and cyclical components of each series were estimated using the same approach described for the reference series. To facilitate a comparison with the reference series, the variability of each indicator series (measured by the standard deviation) is adjusted to conform to that of the reference series.

Composite leading indicators were calculated as the average of various individual indicators adjusted for the leading relationship with the reference series. As with the individual indicator series, the variability of each composite indicator series is standardised to conform with that of the reference series.

It is often useful to present the individual and composite leading indicators in a form that enables a direct comparison with the original reference series. The trend restored form of a leading indicator is equal to the cyclical component multiplied by the trend of the reference series (adjusted for the leading relationship of the indicator with the reference series).

Criteria for selection of leading indicators

The main criteria used in selecting the final set of individual and composite leading indicators are:

- there must be an economic rationale for the lead relationship between the indicator and the reference series;
- data should be available on a timely basis and not subject to significant revision;
- the time series should be long enough to enable a comparison of recent cycles, but it is preferable to have at least one individual or composite indicator that covers the complete period since 1970;
- cycles of the indicator series should be similar to and lead those of the reference series; and
- the lead time of the indicator series should be relatively consistent over time (or where there are significant changes, some understanding of the causes of the different lead times would be relevant for interpreting future movements in the reference series).

Further information on the construction and assessment of each indicator is given in Hogan, Fainstein and Copeland (2001). The OECD approach to constructing leading economic indicators is documented in OECD (1997).

Leading indicators for reference coal prices

Reference coal price series

The cyclical component of the reference coal price is presented in figure B. During the 1970s and early 1980s, cyclical behavior in the reference coal price was strongly influenced by the oil price shocks in 1973-74 and 1979-80 which resulted in substantial switching, mainly in electricity generation, to lower cost energy sources such as coal. The reference coal price was above trend in the periods JFY1975–78 and JFY1981–82.

Following each oil shock, OECD countries experienced significant economic downturns. During this period medium term fluctuations in industrial production in the industrialised economies were countercyclical to those in the reference coal price. For example, following the first oil shock, the peak in the reference coal price occurred in April 1975 while the trough in industrial production in Japan occurred in June 1975.

With the exception of the most recent increase in world oil prices, since the mid-1980s cyclical fluctuations in the reference coal price and world oil prices have been more closely aligned with the business cycle.

In aggregate, there have been five peaks and six troughs in the cyclical component of the reference coal price since the early 1970s. The average amplitude of the peaks is 8 per cent (above trend), slightly lower than the average amplitude of the troughs of 10 per cent (below trend). The average duration of cycles during this period is six years.

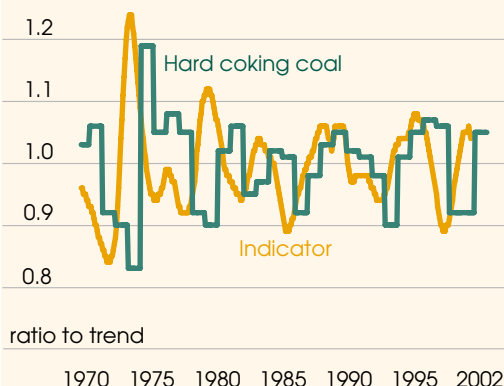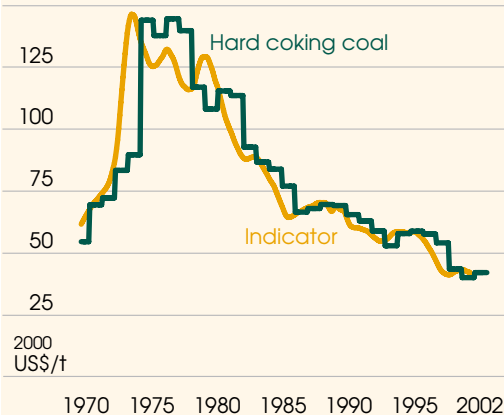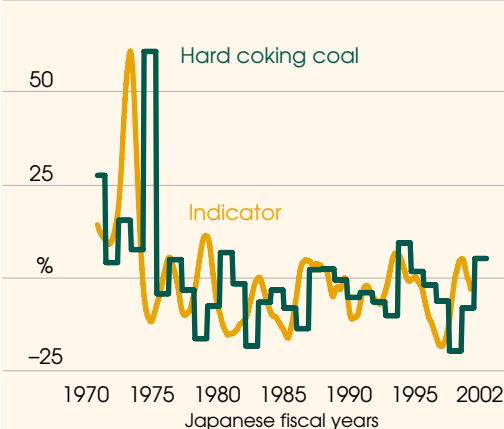### Leading economic indicator – longer time series

One leading economic indicator estimated by Hogan, Fainstein and Copeland (2001) is constructed from long time series data on oil and other commodity prices in world spot markets. This indicator and the reference coal price are presented in figure B in three forms — the cyclical components are given in panel a, the trend restored form in panel b and the annual percentage change in panel c.

The indicator is calculated over the period August 1970 to December 2000 and is a *medium term leading economic indicator*. Movements in the indicator are most strongly related to those in the reference coal price at a lead–lag relationship of 12 months (the correlation coefficient is 0.85 at this lead time).

The latest coal price upturn is likely to have been at least partly caused by switching from oil to coal use in electricity generation, particularly in developing countries, as a result of the substantial increase in real world oil prices during 1999 and 2000. It should be noted, however, that the oil price upturn was from a trough in late 1998 that was large by historical standards.

B Leading indicator for
the reference coal price,
longer time series
Medium term (12 months)

a. Cyclical components

Hard coking coal

Indicator

ratio to trend

1970 1975 1980 1985 1990 1995 2002

b. Trend restored form

Hard coking coal

Indicator

2000
US$/t

1970 1975 1980 1985 1990 1995 2002

c. Annual percentage change

Hard coking coal

Indicator

%

1970 1975 1980 1985 1990 1995 2002
Japanese fiscal years

The recent upturn in reference coal prices occurred during a period when there were indications that industrial production in Japan had commenced a downturn phase. Leading economic indicators that incorporate cyclical fluctuations in industrial production are described in the next section.

Although there is some indication that the lead time may have lengthened in the most recent cycle, the lead time in the late 1980s and 1990s tended to be around ten months compared with thirteen months in the previous period.

The lead time of twelve months therefore needs to be regarded with some caution when interpreting the series for future movements in contract hard coking coal prices. However, it should be noted that the historical point forecasts based on a twelve month lead time are more accurate than naive no change forecasts.

Between September and December 2000, the annual percentage change in this indicator was negative, suggesting downward pressure on the reference coal price in late 2001 (see table 1). A point forecast based on a twelve month lead time requires updated information on the indicator for April 2001.

Leading economic indicators – shorter time series

Several economic variables are found to contain useful information for future movements in the reference coal price, although long time series are not available in most cases. Three leading economic indicators were estimated from these variables, providing a range of lead times for the reference coal price.

A *shorter term leading economic indicator* leads the reference coal price series by six months (with a correlation coefficient of 0.96) over the period October 1989 to December 2000. This indicator is an average of spot prices of coal, crude oil and other commodities, industrial production in Japan, and Australia's coking coal exports as a percentage of coking coal export stocks.

A *medium term leading economic indicator* leads the reference coal price series by ten months (with a correlation coefficient of 0.93) over the period June 1989 to December 2000. This indicator is an average of crude oil and other commodity spot prices, the

OECD composite leading indicator for industrial production in Japan, and Australia's coking coal exports as a percentage of coking coal export stocks.

A *longer term leading economic indicator* leads the reference coal price series by twenty-one months (with a correlation coefficient of 0.89) over the period July 1988 to December 2000. This is an individual indicator based on Australia's coking coal exports as a percentage of coking coal export stocks.

The annual percentage change in the shorter, medium and longer term indicators is presented in figure C, panels a, b and c respectively. Information on the annual percentage change for these indicators during 2000 is provided in table 1.

Since data are available only since the late 1980s for each of these indicators, their reliability in indicating future movements in reference coal prices may only be judged on the basis of two cycles at most. The correlation coefficients are relatively high for the specified lead times, although there is considerable variability in the lead time at turning points.

Each of these indicators provided point forecasts that were substantially more accurate than naive no change forecasts.

For the time period considered in the study, the longer term leading economic indicator is the only indicator at this stage that provides a point forecast for JFY2002. Based on the July 2000 estimate, which is consistent with a lead time of twenty-one months to April 2002, the reference coal price in JFY2002 is forecast to decline by around 1.7 per cent in real terms or rise by around 0.8 per cent in nominal terms.

Conclusion

In this article, four leading economic indicators have been presented for contract prices of Australia's hard coking coal exports to Japan. These indicators signal future movements in reference coal prices for lead times ranging from around half a year to nearly two years. Importantly, the historical forecasting accuracy of each of these indicators was found to be superior to that for a naive no change assumption.
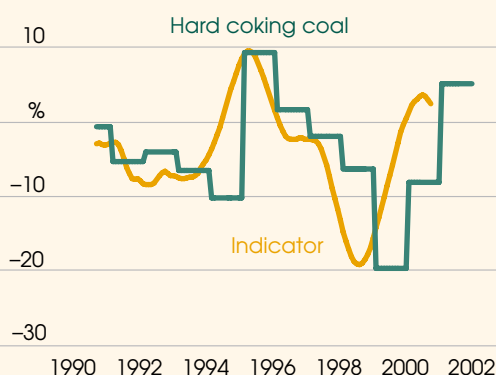
The cyclical behavior of contract hard coking coal prices is similar to that for
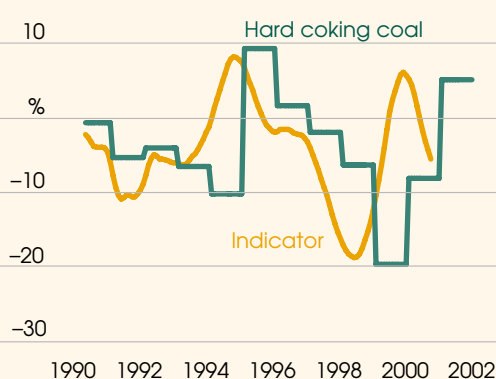
C Leading indicators for the reference coal price, shorter time series
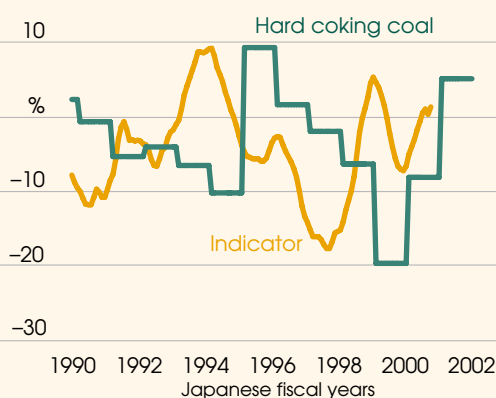Annual percentage change

a. Shorter term leading indicator (6 months)

b. Medium term leading indicator (10 months)

c. Longer term leading indicator (21 months)

Japanese fiscal years

1 Leading economic indicators for contract hard coking coal prices (in 2000 US$) [a]
Percentage change from corresponding month of previous year

| | Longer time series | Shorter time series | | |
	Medium term (12 months)	Shorter term (6 months)	Medium term (10 months)	Longer term (21 months)
2000	%	%	%	%
January	4.3	–1.3	5.9	–7.0
February	4.8	–0.3	6.2	–7.2
March	5.0	0.5	5.8	–6.6
April	5.1	1.4	5.3	–5.0
May	4.9	2.3	4.5	–4.0
June	3.8	2.8	3.2	–3.0
July	2.4	3.1	1.6	–1.7
August	1.1	3.5	–0.1	–0.6
September	–0.1	3.7	–1.7	0.6
October	–0.7	3.5	–3.1	1.1
November	–1.4	3.0	–4.3	0.4
December	–3.1	2.5	–5.5	1.4

a The number of months associated with each indicator is broadly indicative of the lead relationship between the indicator and the reference coal price series.

contract prices of other major coal categories (semisoft coking and thermal coal) and Australia's coal export unit values. The leading economic indicators are therefore also likely to provide useful leading information for these prices.

Feedback

ABARE and the Department of Industry, Science and Resources are seeking feedback from coal market analysts on the potential usefulness of updating and publishing leading economic indicators for Australia's coal export prices on a regular basis.

Key questions for consideration are:
- Should leading indicators be reported for contract prices of semisoft coking coal and thermal coal in addition to hard coking coal?
- Should leading indicators be reported for spot coal prices and, if so, which spot prices?
- In what form should the information on leading indicators and the corresponding reference series be reported — cyclical components, trend restored form or percentage change?
- How frequently should the leading indicators be updated and published (for example, monthly or quarterly), if at all?

Any comments on these or related issues would be appreciated and should be directed to Lindsay Hogan from ABARE (phone +61 2 6272 2034; email: lhogan@abare.gov.au).

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