Coal and Iron Ore Derivatives Markets: A Future?

The move from annual benchmark iron ore prices to quarterly contracts based on spot market rates combined with the greater proportion of trade being conducted on the spot market implies a significant increase in price volatility for a major traded commodity, and one of Australia's major exports. Recent media commentary has focused on the potential for changes to iron ore pricing to generate a large iron ore derivatives market, although this market remains in its infancy. The development of the European coal derivatives market following deregulation of the European electricity market in the early 2000s provides a recent example of how a derivatives market can develop once demand is established. This note examines the development of the coal derivatives market and the current status of the iron ore derivatives market.

Background

Traditionally, iron ore prices have been fixed in the short term, as the majority of iron ore trade has been conducted using annual contracts. This benchmark pricing system was established between Australian exporters and large Japanese steel mills nearly half a century ago, when the spot market was non-existent.

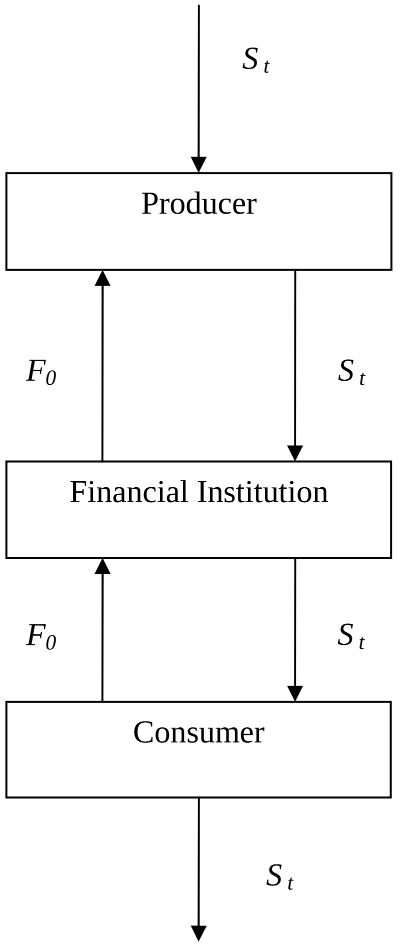
However, recent developments mean that producers and consumers are now facing much higher price variability. The growing dominance of the Chinese steel industry, which is less concentrated than in Japan, has seen an increase in the proportion of trade done on the Chinese spot market in recent years. Further, the growth of an alternative market place placed the existing contract system under intense pressure. As spot prices increasingly diverged from contract prices (Graph 1), the incentives for miners and steel mills to make use of the spot market strengthened – to the point where Chinese steel mills openly reneged on contracts as the spot price dropped below the contract price in late 2008. These pressures finally culminated in a move away from annual benchmark prices to quarterly prices based on spot market rates in 2010.

Significant media attention has been focused on the implication of this change in pricing on the development of iron ore derivatives markets, with volumes predicted to increase rapidly. However, iron ore derivatives remain at a very early stage of development, making it difficult to adequately assess these claims. This note will examine the conditions that facilitate the development of commodity derivatives markets, and presents the development of a coal derivatives market in Europe as a case study for how iron ore derivatives may develop in the future.

Development of Commodity Derivative Markets

There is a natural progression in the development of derivative markets, although the speed of each stage will vary considerably depending on the demand for the instruments. A prerequisite (or co-requisite) for commodity derivatives is the development of at least one benchmark spot price index to provide a transparent reference price for market participants that reflects underlying market activity. These prices are initially used by participants to write over-the-counter (OTC) instruments, forwards and swaps being the most popular. Commodity swaps are effectively a series of cash-settled forward contracts on a commodity over a number of time periods.[1] For example, a producer of a particular commodity selling in the spot market has a variable income stream. To stabilise their income, they would enter into a swap where they agree to receive a fixed rate in exchange for paying a floating rate (linked to the spot price). Figure 1 illustrates a simple fixed-for-floating commodity swap.

Figure 1: Commodity Swap



Producer

t = 0 — Agrees to pay spot price S_t to a financial intermediary in exchange for receiving pre-determined fixed payment F_0

t = 1, 2…,T — Sells their commodity and receives spot price S_t.

Pays S_t to financial intermediary and receives F_0

Consumer

t = 0 — Agrees to pay F_0 to financial intermediary in exchange for receiving S_t

t = 1, 2…,T — Pays S_t to buy commodity

Pays F_0 to financial intermediary and receives S_t

Both the producer and consumer have hedged their price risk independently of each other

If a bilateral OTC market becomes sufficiently developed, exchanges may offer clearing services for these derivatives, which allow participants to eliminate the counterparty risk normally associated with bilateral contracts. Cleared OTC swaps require standard contract sizes, qualities and margining. Standardisation of contracts is also a prerequisite for the development of futures contracts, which are generally offered only after turnover in the OTC market is sufficiently large. This sort of progression was seen in the development of oil and coal derivative markets.

[1] Forwards and swaps account for around two thirds of commodity OTC trade according to BIS statistics.

Case Study – Development of Coal Derivatives Market

The thermal coal derivatives market provides a recent example of how a large derivatives market can evolve given the right catalyst. In this case, the catalyst was the deregulation of the European power market in the late 1990s and early 2000s; coal consuming utilities that had typically had a regional or national monopoly were suddenly faced with increased competition. No longer able to simply pass on coal price increases to consumers, the energy utilities instead turned to derivative contracts as a means of hedging their price risk.

Tradition Financial Services (TFS) – an OTC brokerage firm – set up a coal desk in 1997 and is credited with introducing the first European benchmark coal index, the API1. In April 1998, TFS traded the world's first cash-settled coal swap, linked to the API1 index. The API2 index was introduced in August 1999 and became the benchmark price index for coal in Europe.[2] A range of coal indices have since sprouted, including the South African benchmark API4 index and the globalCOAL Newcastle index, but the API2 remains the most used (see appendix for more details on these indices).

Standardisation of those contracts began when the European Energy Exchange (EEX) started offering clearing services for OTC coal swaps and a coal futures contract in May 2006. This was followed closely by the introduction of cash settled futures linked to the API2 and API4 indices on the European Intercontinental Exchange (ICE). At this point, estimated turnover in OTC coal derivatives was just larger than the annual seaborne trade in coal (Graph 2), and smaller than annual production of around 4.5 billion tonnes. A futures contract linked to the Newcastle coal index was launched on ICE in December 2008.

Since 2006, the size of the coal derivatives market has grown substantially to reach turnover in 2009 of around 2.5 billion tonnes, compared to seaborne trade of around 700 million tonnes (and global production of around 5 billion tonnes). Derivatives trading is concentrated in Europe, with Asia Risk estimating a ratio of derivatives volumes to physical seaborne trade of 7 in Europe compared to only 0.6 in Asia.[3] Trade in Asia is still primarily conducted using annual contracts, with Asian participants apparently more resistant to switching to spot market pricing than their European counterparts. The bulk of trading remains concentrated in the

[2] The index has been published by Argus media since 2003.

[3] A partial explanation for this could be that Europe imports a greater percentage of their coal consumption than Asia, explaining the greater need for hedging instruments (assuming that contracts are more prevalent in domestic trade than international trade).

OTC market. However, volumes of futures contracts on ICE have increased rapidly in recent years, potentially in response to the price shock brought on by the financial crisis. The majority of trade is concentrated in the European API2 contract (Graph 3), reflecting that European consumers source most of their coal inputs from within Europe. The API2 index measures the price inclusive of transport costs to the landing European port, effectively meaning that European consumers can hedge both coal prices and shipping costs using a single instrument.

Developments in Iron Ore Derivatives

Compared to the coal derivatives market, the iron ore derivatives market is currently at a much earlier stage of development. Benchmark iron ore indices have existed for a few years – all three are linked to Chinese spot prices, reflecting that China accounts for over half of the world's iron ore imports, and are inclusive of shipping costs. The first signs of OTC iron ore derivative trading emerged in early 2008 when Credit Suisse and Deutsche Bank began offering swaps cash settled against these indices. The value of market turnover has since increased to an estimated $300 million, less than 1 per cent of annual trade in the physical product.

However, there is potential for a market to develop. The catalyst in this case is the increasing use of the spot iron ore market and the move toward quarterly price setting for deliveries under contract. As many of the steel mills still deliver to customers under annual contracts with fixed prices, the additional price risk faced by mills should generate demand for hedging instruments.

In a small coup, the first iron ore swap involving the Japanese steel industry was entered into in late June 2010. Mitsui - a Tokyo-based trading house that acts as a middleman between the big iron ore miners and the Japanese steel industry - entered into the swap with Credit Suisse. This was one of the first swap deals conducted outside London, and was perceived as significant because Japan is the second largest importer of iron ore after China, and because the Japanese steel industry has typically been reluctant to use derivative contracts. However, the deal was reportedly for 10,000 tonnes of iron ore per month for the second half of 2010, a relatively small amount in the context of total iron ore trade.

Despite its infancy, there are already moves to standardise contracts and move them to exchanges. The Singapore Exchange (SGX) launched the world's first cleared OTC iron ore swaps contract in April 2009 and LCH.Clearnet, the US Intercontinental Exchange and the CME group have since announced the introduction of trading and clearing services for iron ore swaps. However, futures contracts have yet to be introduced.

Assessment

The iron ore derivatives market is still in its infancy. However, the development appears to be proceeding fairly quickly, with exchanges offering clearing services for OTC swaps much more quickly than was the case for coal. If iron ore follows a similar path of development to coal then this will involve growth in the swaps market at first, with futures contracts being introduced once OTC volumes are sufficient.

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Appendix:

Coal and Iron Ore Market Characteristics

Table 1: Coal and Iron Ore Market Strucuture - Proportion of World Totals

Thermal Coal - 2008					
Production		Exports		Imports	
China	47	Indonesia	26	Europe	28
US	19	Australia	17	Japan	18
India	9	Russia	13	South Kore	11
Europe	8	Colombia	11	China	5
Other	17	Other	34	Other	37
Iron Ore - 2004					
Production		Exports		Imports	
China	38	Australia	38	China	52
Australia	22	Brazil	34	Europe	17
Brazil	12	India	11	Japan	16
India	7	South Afric	4	South Kore	6
Other	21	Other	12	Other	9

Sources: USGS; Barclays; EIA

Benchmark Coal and Iron Ore Indices

Index	Underlying data	Location	Calculation	Derivative contracts based on index	Typical derivative contract details
			Coal		
API2	Argus CIF ARA and McCloskey's NW European steam coal marker prices NCV 6000 kcal/kg Size range = 50mm	Europe: ARA (Amsterdam-Rotterdam-Antwerp)	Average of the two underlying data series Argus CIF ARA is an average of the weighted transaction price for cargoes delivered to ARA and consensus price estimates McCloskey's marker prices are compiled by assessing the market through a combination of reported physical activity (i.e. trade prices, bids and offers) and the results of a survey which polls market participants at the end of every day.	ICE futures (began late 2006) European Energy Exchange (EEX) futures OTC swaps	Contract size: 5000 metric tonnes.
API4	Argus FOB Richards Bay and McCloskey's FOB Richards Bay marker prices NCV 6000 kcal/kg Size range = 50mm	South Africa – Richards Bay	Average of the two underlying data series Same process as the API2.	ICE Futures (began late 2006) EEX futures OTC swaps	Contract size: 5000 metric tonnes.
globalCoal Newcastle monthly index	globalCOAL Newcastle weekly Index NCV 6000 kcal/kg Size range = 50mm	Australia - Newcastle	Volume weighted average of weekly bid-offer and transaction prices.	ICE Futures (began late 2008) OTC swaps	Contract size: 5000 metric tonnes.

Iron Ore					
Platts IODEX (62% Fe). Other indexes exist for other purities: 58%, 63/63.5% and 65%.	Prices of fines of 60-63.5% Fe are obtained. Normalised to 62% Fe.	CFR Main Chinese ports (mainly Qingdao, prices to other ports are normalised to Qingdao).	Binding quotes at 16.30 Singapore time	Standardised OTC swap cleared on ICE US.	Contract size: 1000 dry metric tonnes. Settlement price is average of daily index over expiring month.
Metal Bulletin Iron Ore Index (MBIO Index)	Prices of fines of 58-66% are obtained. A sub-index for C, T and P are constructed using prices if available (quotes are averaged and only used if prices are not available). The average of the three indices is the official index value. All prices 4% away from the average of all initial prices are excluded and the index recalculated once.	CFR Qingdao	Transaction prices and indicative quotes from consumers, producers and traders. Pricing data also sourced from SteelHome, an independent Chinese steel data provider and consultancy based on contacts in the Chinese market.	Only bilaterally-settled swaps, generally covered by an ISDA agreement.	
The Steel Index (TSI) Iron Ore Reference Price	Prices for fines of 60-68%Fe and then normalised to 62% Fe. Outliers are excluded.	CFR Tianjin Port, China	Transaction prices from a range of producers and consumers who are registered to provide prices.	Standardised OTC contracts cleared through SGX AsiaClear and LCH.Clearnet	Contract size of 500 metric tonnes. Settlement price is average of daily index over expiring month.

An Analysis of Iron Ore Price Forecasts

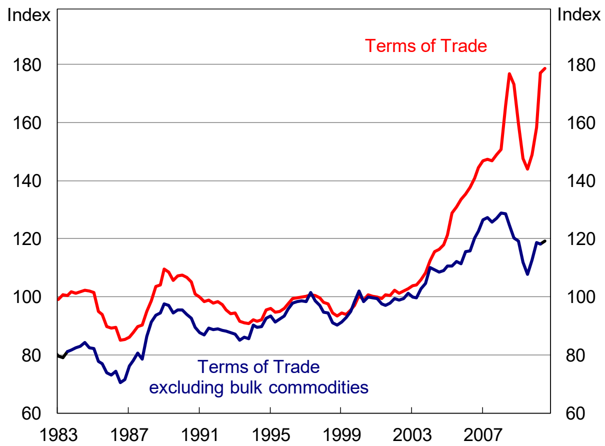
We assess the performance of both market economists and the forward curve in forecasting iron ore, and compare their performance with alternative forecasting methods, using swap market and naive forecast models. During this period we find that none of the sources of iron ore price expectations performed particularly well, producing large forecast errors and downward bias. Our results show that the naive model performed slightly better than the swap and forward curves, while the market economists forecasts was found to be the best forecast indicator over shorter forecast horizons. This is likely due to the strong run-up in prices that occurred during the time period of our analysis, although other possibilities such as market infancy and illiquidity should not be ignored.

Introduction

Iron ore is Australia's largest resource export by value, accounting for around 18 per cent of all Australia's exports. Over the past decade iron ore prices have risen substantially, driven by strong demand from China's steel industry and constraints in supply (Graph 1). The rising price of iron ore (and other bulk commodities) has been one of the major determinants of movements in Australia's terms of trade, underpinning its rise to historically high levels (Graph 2). This has had significant ramifications for Australia's nominal incomes, and has also motivated a substantial amount of investment. Given the impact of iron ore prices on Australia's terms of trade and the wider economy, it is important for EAF to provide robust forecasts of iron ore prices. Currently EAF relies on two external sources of iron ore price expectations to complement their own judgement; market economist forecasts (henceforth referred to as C*onsensus*) and the forward curve.

Graph 2

Terms of Trade
2000 = 100



Sources: ABS; RBA

In this note, we assess the forecast performance of the C*onsensus* forecasts and the forward curve over recent years, in order to determine how much weight EAF should place on these sources in the formation of their iron ore price forecasts.[1] We also compare the performance of these indicators to alternative iron ore forecast methods currently not in use by EAF; the swap market and a naive forecast, to explore whether these are the most accurate sources of iron ore price expectations available.

The international iron ore market

Iron ore is traded internationally either through long-term contracts or the iron ore spot market. Traditionally, iron ore trade was conducted using only annual contracts. Prices would be negotiated between the major iron ore exporters and the major steel mills. The first agreed

[1] Analysis of each source of iron ore price expectations is examined for as long as data constraints would allow. For more details see 'Forecast Models and Data' section.

on price would then act as a benchmark for the rest of the industry to follow for the next Japanese fiscal year (June-March). This system of benchmark pricing was established between Australian exporters and Japanese steel mills nearly half a century ago, well before the spot market existed.

In the last decade, the industrialisation of China and the growing dominance of the Chinese steel industry, (which is less concentrated than the Japanese steel industry), has meant that a greater proportion of iron ore trade has been conducted using the spot market. In contrast to the annual contracts, the spot market fluctuates in response to rapidly changing market conditions.

In recent years, spot prices have been quite volatile and have increasingly diverged from contract prices. This has encouraged the development of iron ore derivative markets, such as the forward and swap markets in 2008, and has also put pressure on the benchmark pricing system, leading to the adoption of quarterly contracts in 2010.

Forecast models and data

In order to assess *Consensus* forecast and the forward curve we use two data sources: quarterly Access Economics Minerals Monitor publications and daily Credit Suisse Iron Ore forward prices. We also analyse two alternative sources of iron ore price expectations, the swap market (Singapore Exchange Iron Ore swap prices) and a naive forecasting model. It should be noted that we have significant limitations to the availability of the data.

Consensus forecasts

Every quarter, Access Economics collects and publishes commodity price forecasts that are made by a range of public and private sector institutions, including Deutsche Bank, Macquarie Bank and Citigroup. Analysts at these institutions consider a number of qualitative and quantitative factors when compiling their forecasts; in particular, they likely focus on factors such as global GDP growth, industrial production and resource-related investment. Access Economics then publishes individual and consensus forecasts of fine and lump iron ore free-on-broad (FOB) contract prices one to ten quarters ahead. We use the consensus forecast of iron ore (fines) contract prices to assess the forecasting performance of market economists. Consensus forecasts are available from September 2005 to October 2010.

Forward Curve

A forward contract is an agreement by which a seller agrees to deliver a specified commodity to a buyer at some specified point in the future. The price for delivery (referred to as the forward price) is a function of the prevailing spot price and expectations of economic and market conditions going forward. Thus, the forward price could be a useful predictor of spot prices.

In order to assess whether this is the case for iron ore spot prices, in our analysis we use daily Credit Suisse Iron Ore forward prices for contract delivery for one to six quarters ahead. The forward price is based on CIF China 63.5% Fe fines, and provides quarterly average forecasts up to six quarters ahead of the iron ore (fine) spot price. Data are available from mid December 2008 to the end of November 2010.

Swap Market

Iron ore swaps are exchange-traded derivative contracts, used by iron-ore market participants to hedge against volatility in the physical iron ore spot market. Iron ore swaps are effectively a series of cash-settled forward contracts on iron ore over a number of time periods. Since they are forward looking, iron ore swaps should also provide an indication of where spot prices are heading.

We use daily Singapore Exchange (SGX) Asiaclear Iron Ore CFR China 62% Fe Fines swap prices for cash settlement for one, two and four quarters ahead. The contract is cash settled at the end of the each month using the arithmetic average of The Steel Index (TSI) iron ore reference prices in the expiring month. The earliest data is available is from mid May 2009.

Naive Model

We also use a naive model to assess whether these data sources are indeed a good indication of future iron ore prices. The naive model assumes that there is no change in iron ore prices, so that the forecast of iron ore prices for *s* steps into the future is the current value of iron ore prices. Such a forecast would be optimal if iron ore prices follow a random-walk process. To test this we construct naive forecasts, using past values of iron ore contract prices and past values of iron ore spot prices.

Method

Due to differences in the data used to assess each indicator, such as frequency, sample size, and time frame, we have to assess the forecast performance of the consensus forecasts, the forward curve and the swap market separately. We then attempt to evaluate the relevant performance of each indicator from mid May 2009 to the end of October 2010 – the window for which we have data available for all indicators.

Our evaluation tools are the Root Mean Square Error (RMSE), the Mean Absolute Percentage Error (MAPE), and the Mean Percentage Error (MPE). The MPE determines whether any indicator has a tendency to over or under-predict iron ore prices. A value very close to zero implies that the indicator is unbiased, while a value that is a large positive (negative) implies that the indicator is consistently underestimating (overestimating) iron ore prices.

Theil's U-statistic is also calculated to determine whether the indicator performs any better than the naive forecast model. A U-statistic of one implies that the indicator and the naive model are equally accurate, while a values less (greater) than one implies the model is superior (inferior) to the naïve forecast.

Results

Consensus forecasts: Sep 2005 – Oct 2010

The forecast performance of the consensus forecasts are summarised in Graph 3 and Table 1. Over this period the consensus forecasts performed quite poorly. They consistently failed to predict the magnitude of the movement in contract prices. This is highlighted by the large MAPE values, which ranged from 17 per cent to 35 per cent (Table 1). The consensus forecasts also showed a tendency to underestimate the actual iron ore contract price, particularly for longer forecast horizons (shown by the large positive MPEs). Although the consensus forecasts were not particularly accurate, they did perform better than the naive model (where contract prices were held constant) over all forecast horizons, as shown by Theil's U-statistic.

Table 1: Performance Evaluation of Consensus Forecasts
Sept 2005 – Oct 2010

	U-Statistic	MAPE (%)	MPE
Contract 1	0.69	17.18	8.27
Contract 2	0.76	30.25	19.64
Contract 3	0.70	34.51	34.51

Forward curve forecasts: Dec 2008 – Nov 2010

The forecast performance of the forward curve during this period is summarised in Graph 4, and Table 2. During this period, the forward curve performed poorly. It consistently failed to predict the direction and magnitude of iron ore price movements, as highlighted by the large MAPE values recorded over all forecast horizons, ranging from 33 per cent to 48 per cent (for 3-5 quarter ahead forecasts). The consistently positive MPEs suggests that the forward curve had a tendency to under-predict the actual iron ore spot price during this time, with a naïve forecast providing a better indication. However, this may be because we are taking a snapshot of forecasting performance during a time when prices were mostly rising – we discuss this issue in more detail below.

Table 2: Performance Evaluation of Forward Curve and Naive Model
Dec 2008 – Nov 2010

	Forward Curve		
	U-statistic	**MAPE (%)**	**MPE**
Q1	1.38	10.55	9.26
Q3	1.30	33.14	33.14
Q5	0.98	47.60	47.60
	Naive Model		
	U-statistic*	**MAPE (%)**	**MPE**
Q1	--	7.60	2.74
Q3	--	24.56	23.04
Q5	--	45.60	45.60

**For naive model will always equal one.*

Swap market forecasts: May 2009 – Oct 2010

Table 3 and Graph 5 display the forecast performance of the swap market for this period. The swap market, like the consensus and the forward curve forecasts, performed poorly. During this period the swap curve failed to accurately predict the magnitude of iron ore spot price movements, resulting in large MAPE values over all forecast horizons, which ranged from 16 per cent to 41 per cent.

The swap curve also tended to under predict the actual iron ore spot price. The large positive MPE values recorded over all forecast horizons shows that the swap curve was biased downwards during this period.

Table 3: Performance Evaluation of Swap Market and Naive Model Forecasts May 2009 – Oct 2010			
	Swap Market		
	U-statistic	**MAPE (%)**	**MPE**
Q1	1.02	15.94	10.61
Q2	1.03	23.41	20.66
Q4	1.09	40.98	40.98
	Naive Model		
	U-statistic*	**MAPE (%)**	**MPE**
Q1	--	15.13	7.74
Q2	--	22.48	17.73
Q4	--	37.68	37.68

*For naive model U-statistic will always equal one

Discussion

We have found that all indicators performed poorly during the last couple of years, producing large forecast errors and were found to be biased downwards. This is most likely because our analysis is restricted by data constraints to a period where there was a large run-up in iron ore prices. The iron ore market and economists may have therefore under-estimated the strength of China's economic performance and strength of demand. Further, during this cycle, the forward and swap curves were mostly downward sloping, suggesting that future iron ore prices would fall, when in fact they actually rose.[2] This would explain why these indicators recorded such large positive MPEs during this period; and why the naive model (which held spot prices constant) performed just as well if not better than the forward and swap curves.

The poor performance of the forward and swap curves could also be attributed to the infancy and current illiquidity of the iron ore derivatives market. The first over-the-counter (OTC) derivative trading in iron ore occurred in May 2008, when Credit Suisse and Deutsche Bank began offering cash-settled swaps. Since then, activity in derivative markets has been quite low, accounting for just 1 per cent of annual trade in the physical product. In light of this our results should be interpreted as being specific to this sample period.

Comparison of forecasting performance: May 2009 – Oct 2010

To compare consensus, forward and swap, the frequency of the market-based data is reduced to quarterly to match consensus. Our sample size is thereby reduced, with only thirty-three observations for each iron ore price indicator. The results are summarised in Table 4. Graph 6 and Graph 7 shows the forecast performance for the consensus forecasts, the forward curve and the swap market. During this period, all three indicators performed poorly over longer forecast horizons (more than two quarters ahead). This is highlighted by the large MAPE values, which ranged from 38 per cent to 47 per cent (Table 4).

However, for shorter forecast horizons, the MAPE and RMSE values show that the consensus forecasts performed better than the market-based indicators. This is as we would expect since the consensus provides quarterly forecasts of iron ore contract prices, while the forward and swap curves are predicting quarterly and monthly averages of the iron ore spot price, respectively, which are inherently more volatile. Further, the RMSE for consensus forecasts for one quarter ahead should be zero, or close to zero, as the contract price for one quarter ahead will typically be known by the forecaster.[3]

[2] When the forward or swap price is below the current spot price, the forward (swap) curve is said to be in backwardation.

[3] A RMSE value that differs from zero for one quarter ahead forecasts is most-likely due to human error i.e. a forecaster may have reported their forecast in the wrong units, or thought they were forecasting the spot rather than the contract price. EAF has taken account of this in recent Mineral Monitor releases (2010) by adjusting the data to exclude individual forecasts which were clearly incorrect or out-of-date, or to replace a forecast with a more current forecast by that provider if we were aware of one. For more details see \Energy and Metals Consensus Forecasts - Survey Details.doc

By the fourth quarter the consensus forecasts performed worse than the market-based indicators, on average missing by 47 per cent, in comparison to the forward and swap curves that missed by 41 per cent and 38 per cent respectively. The market based indicators produced very similar forecasts of iron ore spot prices (Graph 7). Both curves had similar slopes, and tended to show correlation, and this is highlighted by the similar MAPE and RMSE values for quarter's two and four (Table 4). Over shorter forecast horizons however, the MAPE values show that the forward curve on average performed relatively better than the swap curve.

Table 4: Performance Evaluation of Forecasts of Iron Ore Prices

	RMSE		
	QTR 1	**QTR 2**	**QTR 4**
Consensus	2.49	21.80	64.31
Forward	14.08	40.18	65.71
Swap	19.74	36.73	56.78
	MAPE (%)		
	QTR 1	**QTR 2**	**QTR 4**
Consensus	1.48	10.55	47.44
Forward	9.74	25.40	40.86
Swap	14.17	23.86	37.83

Conclusion

We found that none of the iron ore price indicators performed particularly well over the period examined, with all producing large forecast errors and exhibiting downwards bias. We found that a naive forecast performed slightly better than the forward curve, and no worse than the swap curve, in predicting future iron ore spot prices. The poor performance is most likely a result of the strong run-up in prices that occurred during the time period of our analysis, although other possibilities such as market infancy and illiquidity should not be ignored.

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Appendix

Tables 5 and 6 summarise the RMSE, MAPE and MPE values, used to compare the performance of the consensus forecasts with the forward curve from December 2008 to November 2010, and the forward curve with the swap curve from May 2009 – October 2010. The same data frequency is used. These results (which are a larger sample size) support our findings in *Comparison of forecasting performance: May 2009 – Oct 2010* presented in this note.

Table 5: Forecast Performance of Forward Curve and Consensus Forecasts December 2008 and November 2010			
	Forward		
	RMSE	**MAPE**	**MPE**
1Q	12.33	8.54	7.59
2Q	35.27	23.38	14.69
3Q	43.02	25.98	25.41
4Q	58.72	38.28	38.28
5Q	73.46	47.09	47.09
6Q	80.77	50.89	50.89
	Consensus		
	RMSE	**MAPE**	**MPE**
1Q	2.16	1.13	0.36
2Q	18.43	7.83	7.47
3Q	35.92	16.49	16.06
4Q	49.82	28.87	28.82
5Q	61.78	40.33	40.33
6Q	74.96	55.72	55.72

Table 6: Forecast Performance of Forward Curve and Swap Market May 2009 and October 2010			
	Forward		
	RMSE	**MAPE**	**MPE**
1Q	18.54	11.74	10.89
2Q	37.43	23.76	20.83
4Q	67.72	41.90	41.90
	Swap		
	RMSE	**MAPE**	**MPE**
1Q	23.49	15.94	10.61
2Q	39.03	23.41	20.66
4Q	64.97	40.98	40.98