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Analysis of key value drivers for differing value performance of major mining companies for the period 2006 - 2015

Jack MacDiarmid

A research report submitted to the Faculty of Engineering and the Built Environment, University of the Witwatersrand, in partial fulfilment of the requirements for the degree of Master of Science in Engineering.

Johannesburg, 2017

DECLARATION

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ABSTRACT

The period from 2006 to 2015 was a turbulent one for mining companies. The end of the 2000s commodity super cycle resulted in all-time high market values for most commodity based companies, followed by a rapid decline in value with the onset of the Global Financial Crisis in 2008 and a similar rapid recovery following this. Whilst much of this change in value was driven by commodity prices, the inconsistent performance between companies suggests that there are other factors affecting mining company value.

To determine the key drivers of company value, four diversified and international mining companies which represent close to 50% of the 2006 industry revenue were selected for analysis. These were Anglo American, BHP Billiton, Rio Tinto and CVRD-Vale. Financial and production data was collected to analyse different potential value drivers. Because of its suitability for comparison of company value, the market based valuation approach was selected as the company valuation technique. Enterprise value (EV) was the metric used for company value since this provides a measure of the real market value of a firm as a whole business. Eight potential value drivers, which include production output, commodity price, revenue, EBITDA margin, EBITDA multiple, gearing ratio, net debt to EBITDA ratio and ROCE, were selected for analysis. Each potential value driver was tracked against EV to determine if there was any correlation between the value driver and EV. Also, the Pearson correlation method was used to determine correlation between each potential value driver and EV.

Production output and commodity price in isolation were found not to drive company value. However, when combined to calculate revenue, had a very high correlation to EV with an average Pearson coefficient of 0.8. EBITDA multiple was also found to be a key driver of company value, with this metric closely aligned to revenue (Pearson coefficient of 0.6). The two debt metrics, gearing ratio and net debt to EBITDA were found to only have a correlation to EV in times of declining commodity prices and revenue. EBITDA margin and ROCE were found to have no correlation to EV and as such were not considered to be key drivers of company value. Mining companies must ensure that they focus on the correct value drivers to ensure those they influence do impact the company value.

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LIST OF SYMBOLS

ASX	Australian Securities Exchange
AUD	Australian dollars
bbl	Oil barrel (unit of measure)
BHP	Broken Hill Proprietary
cfr	Cost and freight
ct	Carats
CVRD	Companhia Vale do Rio Doce
dmtu	Dry metric tonne unit
EV	Enterprise value
EBIT	Earnings before interest & tax
EBITDA	Earnings before interest, tax, depreciation & amortisation
FTSE100	Financial Times Stock Exchange 100 Index
FOB	Free on board
GBP	British pounds
GFC	Global financial crisis
HCC	Hard coking coal
JSE	Johannesburg Stock Exchange
KPI	Key Performance Indicator
LSE	London Stock Exchange
Mt	Million metric tonnes
Oz	Troy ounces
P/E	Price on equity analysis
Q1	Quarter 1 – January to March
Q2	Quarter 2 – April to June
Q3	Quarter 3 – July to September
Q4	Quarter 4 – October to December
RBCT	Richards Bay Coal Terminal
ROCE	Return on capital employed
WTI	West Texas Intermediate (oil pricing)
USD or $	United States dollars
$USM	United States dollars (millions)

1 INTRODUCTION

1.1 Chapter overview

This chapter provides an introduction, background and objectives of this research study. Firstly, an introduction to the problem provides the context of the relevance of the research. Then an overview of the research problem and objectives are presented. Finally, an explanation and justification for the selection of the four major mining companies which were analysed as part of this research study, and a background to the history of each of these companies is provided.

1.2 Background

"A commodity super-cycle occurs over multiple decades during which the rise in commodity prices is observed across the board, before declining for a long period" (Media, 2012, p1). The 2000s commodities super-cycle saw widespread growth for most mining companies as rising demand for commodities from emerging markets pushed commodity prices to all-time highs over a very short period of time. This boom was sharply brought to an end in 2008 with the onset of the Global Financial Crisis (GFC) which saw commodity prices declining to close to pre-2001 levels. Since then there has been a recovery and subsequent downturn of commodity prices. Such commodity price cycles are inherent to the mining industry, and something that mining companies understand and plan for.

Throughout these cycles, major mining companies have seen fluctuations in their market values, rising to high levels at the end of the boom times and in some cases dropping just as quickly with downturns in the economy. Whilst the simplest explanation for this would be a direct link between company value and commodities prices, some companies have fared better than others throughout the commodity price cycles. This suggests that commodity prices are not the only

driver of company value and as such mining executives must consider other drivers in order to preserve and increase company value.

The economics of the mining industry is unique compared to that of other industries, with an entire field of study, known as mineral economics, dedicated to this. Factors such as the non-renewable nature of mineral resources, high capital costs, the long lead time required to develop projects, and supply/demand variations make mineral economics generally more complex than economic studies of other industries (Maxwell, 2006). These factors make the valuation of mining companies much more difficult, with numerous factors, or value drivers, influencing performance and value.

The identification of the value drivers can be used by company executives to ensure that all strategic and operational decisions are aligned to the primary company objective of increasing value. As recommended by Krinks *et al*. (2011, p22) every mining company "needs to have a clear plan for differential value creation, beyond relying on commodity prices". An understanding of these value drivers is important for company leaders whose goal is to increase value, through to financial analysts who try to predict changes in company value. An improved understanding and recognition of these drivers will be beneficial to guide decision-making by these industry leaders.

1.3 Research problem and question

Given the varied company performance in terms of market value over the past 10 years whilst operating in the same global commodities market, it would appear that commodity prices are not the sole driver of company value. For example, how is it that Broken Hill Proprietary (BHP) Billiton's share price was up by 50% over the period from 2006 to 2015 yet the share price of another of the majors, Anglo American was down by 60% over the same period? This raises the question: *"What are the value drivers that lead to differences in company value changes?"*

1.4 Research objectives

This study analysed the hypothesis on whether the variable performance in company value between four major mining companies, as measured by enterprise value, can be traced to a number of key value drivers. This hypothesis was explored by analysing company enterprise value over the 10 year period from 2006 to 2015, against identified key value drivers during the same period to determine any patterns between market performance and the value drivers.

The objectives of this research study were to:

- Review available literature on enterprise value to determine possible value drivers;
- Collect the relevant company performance and value driver data from available company reports;
- Develop indexed comparison of company value versus each of the value drivers;
- Analyse this data to identify any correlation and trends between potential value drivers and company value;
- Identify key drivers of company value over the period; and
- Provide a recommendation on where companies should focus in order to preserve and increase company value.

It is important to note that the objective of this project is not to do a specific valuation of any of the mining stocks. Instead, it is to do a statistical analysis of value drivers against indexed enterprise value to determine any trends between value drivers and value. As such valuation techniques such as the discounted cash flow, real option pricing, comparable transaction or other approaches were not considered in this study.

1.5 Research scope

The research study focused on four major international diversified mining companies being, in alphabetical order, Anglo American Plc, BHP Billiton Ltd / South 32, Rio Tinto Group and Companhia Vale do Rio Doce (CVRD-Vale). Whilst Glencore and Xstrata could be considered, their 2013 merger makes it difficult to analyse the pure value drivers to performance over this period, and thus they were excluded as discussed in Section 1.6.

The period from 2006 to 2015 was selected as it represents a range of economic conditions for a comprehensive analysis of mining companies. The period 2006 – 2008 represents a time when the mining boom saw mining companies making extraordinary profits. This was followed by a brief, but drastic downturn with the onset of the GFC, and subsequent rapid recovery during 2010 and 2011. Then following this, the period 2011 to 2015 saw a steady downward trend in commodity prices and increased pressure on mining companies to reduce expenditure and react to these softer prices.

1.6 Selection and justification of mining companies

In order to identify any trends between value drivers and enterprise value, a range of mining companies had to be selected and analysed. However, it is important to note that within the mining industry two distinct sizes of companies exist, the majors and the juniors. The difference between the two is very important for company valuation, as outlined by Beattie (2016). The majors are traditionally well capitalised with steady cash flows. As such, in theory, their enterprise value should be relatively stable or experience steady growth. Juniors on the other hand, tend to be speculative with hopes of a discovery of a feasible mineral resource to boost returns. For this reason the drivers of value are much more difficult to track, reliant on exploration with big risks and reward. Therefore, this

research focused only on major mining companies which can be reliably evaluated for differing performance due to different value drivers.

For the purpose of this report, major mining companies are defined as multiple commodity, publically listed mining companies. For these major mining companies, revenue is essentially a measure of sales, thus, by ranking companies by revenue it was possible to select which companies have the biggest influence on the global commodities market. As such, the companies selected should have revenue which represents a major portion of the total worldwide commodity sales.

According to Price Waterhouse Coopers (2007), for the 2006 calendar year the top four mining companies accounted for nearly 43% of the total revenue and almost 47% of profit before interest and tax for the top 40 mining companies. These top four companies included Anglo American plc, BHP Billiton Group, Rio Tinto Group and CVRD-Vale with their contributions to revenue as shown in Table 1.1. It is possible to increase the share of revenue and profit before interest and tax to above 50% by including a fifth company, which was Xstrata plc.

Table 1.1: Top five mining companies by revenue - 2006
Source: Price Waterhouse Coopers (2007)

	2006 (USD billion)	
Total revenue	237.0	
Anglo American PLC	33.1	14%
BHP Billiton group	32.8	14%
Rio Tinto group	22.5	9%
CVRD-Vale	19.7	9%
Xstrata	17.1	7%
Top 4 companies	109.3	46%
Top 5 companies	126.4	53%

These five companies, at the time and historically, have been considered the world's major international mining companies and should represent a fair range of data for performance analysis. However, this is just a snapshot as of 2006. Over the eight year period following this, from 2006 to 2014, BHP Billiton, CVRD-Vale, Rio Tinto and Xstrata have all remained within the top four revenue earners of mining companies. Anglo American however has made a steady decline year-on-year to be ranked twenty seventh by revenue as of 2015 (Price Waterhouse Coppers, 2016). These 2006 top five companies by 2015 were ranked as per Table 1.2. As can be seen, whilst BHP Billiton and Rio Tinto have retained the top two positions, the other companies have dropped significantly.

Table 1.2: Mining company ranking by revenue - 2015
Source: Price Waterhouse Coopers (2016)

	2015 ranking (by revenue)
BHP Billiton	1st
Rio Tinto	2nd
Xstrata/Glencore	6th
CVRD-Vale	8th
Anglo American	27th

The other three positions for 2015 were filled by companies from three emerging countries. These three companies are China Shenhua Energy Company Limited, Coal India Limited and MMC Norilsk Nickel from Russia. The analysis of the value drivers for these three companies for the period of 2006 to 2015 is much more difficult as their financial details are not readily available in the public domain. As such, the top five companies by revenue from 2006, all of which are international publically listed traditional mining companies, were considered for this research study.

In May 2013 Xstrata formally merged with Glencore, a Switzerland based commodities trading company, to form the mining conglomerate Glencore

Xstrata. At the time of the merger the new London listed company rivalled Rio Tinto for size (Solly, 2013). Since this merger was towards the end of the period of analysis for this research study, it is difficult to isolate this in terms of enterprise value for the company. Whilst the other companies have all gone through smaller mergers, acquisitions and sales during the period of analysis, none of them were as significant as the Xstrata Glencore merger. As such, Xstrata was excluded from this analysis.

Therefore, this research study was restricted to the analysis of the top four mining companies by revenue as of 2006, these being Anglo American plc (referred throughout as Anglo American), BHP Billiton Group (referred to as BHP Billiton), Companhia Vale do Rio Doce (referred to as CVRD-Vale) and the Rio Tinto Group (referred to as Rio Tinto).

1.7 Introduction to the selected major mining companies

This section of the report provides a brief overview and history of the four mining companies selected for analysis. In many cases the history of the company is important to understand changes in productivity and economic performance.

1.7.1 Anglo American plc

According to the company history by Anglo American (2016a), the company was founded in 1917 by Sir Ernest Oppenheimer using a combination of capital from sources in Britain and the United States, hence the name Anglo American. The initial focus for the company was gold mining in the East Rand in South Africa. In the 1920s the company broadened its commodity focus, through exploration for platinum in South Africa and adding diamonds by becoming the largest single shareholder of De Beers. Over the next 50 years the company expanded into coal, copper, iron and a number of other products and services (Spector, 2012). In the late 1960s and early 1970s the company expanded further out of the commodities sector to include the steel and pulp/paper industry through acquisition of Scaw

Metals and Mondi Group. Much of the investment in the non-mining sector was as a result of restrictions in place due to South Africa's Apartheid regime. In 1987 the company purchased a wine estate, Vergelegen, which it still owns at the time of this research study.

By the end of Apartheid in 1994 the company was the world's largest producer of gold and platinum group metals, as well as a major producer of gold, diamonds, copper, nickel, iron ore and coal. With operations worldwide, it was one of the top three mining companies in the world. With the end of Apartheid removing trade restrictions, the company began to sell-off many of its non-core businesses and replaced them with other international mining opportunities.

By the early 2000s Anglo American was still very much a diversified mining company, having changed its primary listing to the London Stock Exchange in 1999. Over the next 10 years the company continued to expand with the following transactions (Anglo American, 2016a):

- 2001 - Purchase of Shell Petroleum Company's Australian coal asset;
- 2002 - Acquired the Los Bronces and El Soldado copper mines in Chile to become Chile's third largest copper producer;
- 2002 – Acquired a major stake in Kumba Resources South Africa, increasing its exposure to iron ore;
- 2007 – Completely divested from gold through the formation and sale of AngloGold Ashanti;
- 2007 – Sold off its Mondi Group, the paper and packaging business;
- 2007 – Made an initial investment in the Minas-Rio iron ore project in Brazil;
- 2012 – Increased its stake in De Beers from 45% to 85%; and
- 2015 – Sold its stake in Lafarge Tarmac – a building materials company.

The company has received significant criticism for its investment in the Minas Rio Iron Ore Project in Brazil. Since its purchase in 2007 for $5.1bn, at close to the peak of the iron ore boom, the total project cost was running well above $13bn in 2015 (Seccombe, 2015). This initial purchase, and subsequent project investment, has weighed heavily on the company's debt levels as is outlined later in this report.

In 2015 Anglo American was the worst performing stock on the Financial Times Stock Exchange 100 Index (FTSE 100) dropping more than 73% for the year, only slightly worse than Glencore's 72% drop (Biesheuvel & Crowley, 2015). However, for the first half of 2016 the share price recovered over half of those losses, as the company promised to reduce debt via the sale of multiple assets and a focus on three primary commodities – diamonds, platinum and copper. As of the end of 2015, the company's revenue was split fairly evenly between five main commodities being platinum, diamonds, coal, base metals (copper and nickel) and iron ore with a very small portion from niobium phosphates and corporate activities.

1.7.2 BHP Billiton Group

BHP Billiton was formed out of a 2001 merger between two small mining companies, Broken Hill Proprietary Limited and Billiton, both with histories dating back to the 1880s (BHP Billiton, 2016a). This merger formed the world's largest diversified resources company with operations in 20 countries and commodities which include aluminium, coal, copper, ferro-alloys, iron ore, titanium, nickel, diamonds and silver, as well as a large energy sector (Pederson, 2005). In 2005, the merged company purchased WMC Resources, an Australian based copper, gold and uranium major, adding uranium to its already diverse portfolio of commodities. Then in late 2007, at the peak of the commodities boom, the company announced plans to take over rival Rio Tinto. However, this did not happen due to the onset of the GFC.

From 2007 the company made a number of small purchases and sales, until in 2014 when it announced plans for a demerger of a number of operations to create an independent metals company based on "a selection of its high-quality aluminium, coal, manganese, nickel and silver assets" (BHP Billiton, 2014a, p1). The company said the remaining assets would allow for a focus on the large, long-life iron ore, copper, coal, petroleum and potash business. The spinoff company, South 32, which formally listed on the Australian Stock Exchange (ASX), London Stock Exchange (LSE) and the Johannesburg Stock Exchange (JSE) in May 2015, has struggled with falling commodity prices, dropping by 50% on the ASX by the end of 2015 and then recovering to the same listing price in September 2016. As this demerger occurred during the period of this research study, South 32's production and performance was included in the analysis.

From 2015 the company has focused on a strategy to "own and operate large, long-life, low-cost, expandable, upstream assets diversified by commodity, geography and market" (BHP Billiton, 2016b, p1). As of the end of 2015, approximately one-third of the company's revenue was from iron ore, one quarter each from petroleum (including potash) and copper and the remainder from coal and other corporate activities.

1.7.3 Rio Tinto Group

According to the history of the company by Rio Tinto (2016b), the company was formed in London in 1873 through the purchase of the rights to mine ancient copper mines in southern Spain. In the 1920s the company started to diversify out of Spain, with investment in copper mines in then Rhodesia, Africa. By the 1950s the company had sold-off two-thirds of its interests in Spain and used these funds to invest in bauxite in Australia. As such, in the 1960's the company started to build a large iron ore empire, which today makes it the world's second largest iron ore producer behind CVRD-Vale (Minerals Council of Australia, 2015). In 1983 the

company added diamonds to its portfolio with the opening of the Argyle Diamond Mine in Australia.

The company continued to grow and in the year 2000, right at the start of the minerals boom, it undertook US$4 billion worth of acquisitions - primarily Australian aluminium, iron ore, diamond and coal assets. This was further backed up by the 2007 acquisition of Alcan, creating a world leader in aluminium production. By the early 2010s the company was a major player in iron ore, aluminium, copper, coal and diamonds. In 2015 the company received over 40% of its revenue from iron ore, close to a quarter each from aluminium and copper/coal (grouped together for reporting) and the remaining 10% from diamonds and other minerals.

1.7.4 Companhia Vale do Rio Doce (CVRD-Vale)

According to Vale (2012a) which provided the history of the company, Companhia Vale do Rio Doce, known then as CVRD, was founded in 1942 by the Brazilian Federal Government, to form a state owned mining company. The company's initial focus was on iron ore, and by 1974 it was the world's biggest exporter of iron ore, a title it still holds at the time of writing this report. In 1997, approximately 42% of the company was auctioned off as part of a partial privatisation of the company. The focus on iron ore remained until the 2000's when the company started to diversify into other minerals. The largest of these diversification moves was the 2006 purchase of the Canadian copper, nickel and other metals producer Inco Limited.

In the following year, as part of its move from being a local iron ore miner to a global diversified company, the group launched a rebranding to be known as Vale rather than the traditional CVRD. In 2007 Vale entered the coal mining sector through the purchase of AMCI Holdings Australia, and opened coal assets in Mozambique. In 2012 the company added gold to its portfolio with the opening

of the Salobo Mine in Brazil. By the end of 2013, after 70 years since formation, the company had a presence in more than 35 countries with operations producing all the major commodities, excluding diamonds, and was one of the top five mining companies worldwide. In 2015 the company received close to 70% of its revenue from ferrous metals, 20% from nickel and the remainder from copper, coal and fertilisers.

1.8 Chapter conclusion and structure of the report

As the history of the four major mining companies included in this research report shows, all are multi commodity, diversified international mining companies. Thus they are appropriate for analysis of value drivers for differing company value performance. Chapter 2 of this report provides a literature review of the theory behind company value and valuation techniques. It also provides a review of possible value drivers for mining companies.

Chapter 3 describes the research methodology used, identifying the value drivers to be analysed and explaining the data collection and analysis process. As all data was collected from publically available company financial and production reports, the different values extracted from these reports are explained. Any calculations required to determine the value drivers are also detailed.

Chapter 4 presents and analyses the data, first by showing the variation in company performance over the 10 year period, and then presenting each of the different potential value drivers for each company. These are primarily presented in graphical form with any required detail provided in the text. Statistical correlation analysis is also undertaken on the valuation multiples and the capital efficiency drivers, to determine the correlation between these and enterprise value. This analysis identifies the potential value drivers which significantly influence and are key to company value performance.

Chapter 5 summarises the results on the identified key value drivers. Conclusions derived from the data analysis and key value drivers are also provided. Finally, this chapter provides a number of recommendations, tying the results back to the objectives and identify how companies should consider these drivers when targeting company value.

2 LITERATURE REVIEW

2.1 Chapter overview

This chapter provides background information on the research topic. Much has been written around the economic theory and practice of company valuation. As such the concept of company value and valuation is introduced, to determine the most appropriate value metric for this study. Mineral asset valuation is also introduced to understand its relevance in comparison to company valuation. Then the different metrics and techniques for market valuation are reviewed and discussed to identify the different possible value drivers which influence company value.

2.2 Overview of company value, value drivers and valuation approaches

Value is defined as the material or monetary worth of something (Oxford Dictionary, 2016). When dealing with company value, this can include not only the monetary value of the business but also shareholder value, employee value and societal value. However, in terms of this study, value and valuation are linked to the monetary value of the business. "Value is a particularly helpful measure of performance because it takes into account the long-term interest of all stakeholders in a company, not just the shareholders" (Koller *et al*., 2005, p3). As such, changes in the value of a company over time can be used as a measure of whether a company has performed positively or negatively. The process to calculate this value is known as company valuation defined by Investopedia (2016a, p1) as a "process of determining the economic value of a business or company". Whilst the most common use of valuation is the buying and selling of operations/companies, as identified by Fernàndez (2007) company valuation can also be used to identify and stratify sources of economic value creation and

destruction. In other words the purpose is to identify the value drivers for a company.

L.E.K Consulting (nd, p2) suggested that "by focusing on value drivers, management can prioritize the specific activities that will affect performance in each area". However, for many companies the challenge is to understand which value drivers have the biggest influence on company value. Similarly, whilst some value drivers may have a big impact on value, management may have little influence on these and not be able to change them. The different value drivers, based on value impact and management influence should therefore be ranked and considered as per Figure 2.1.

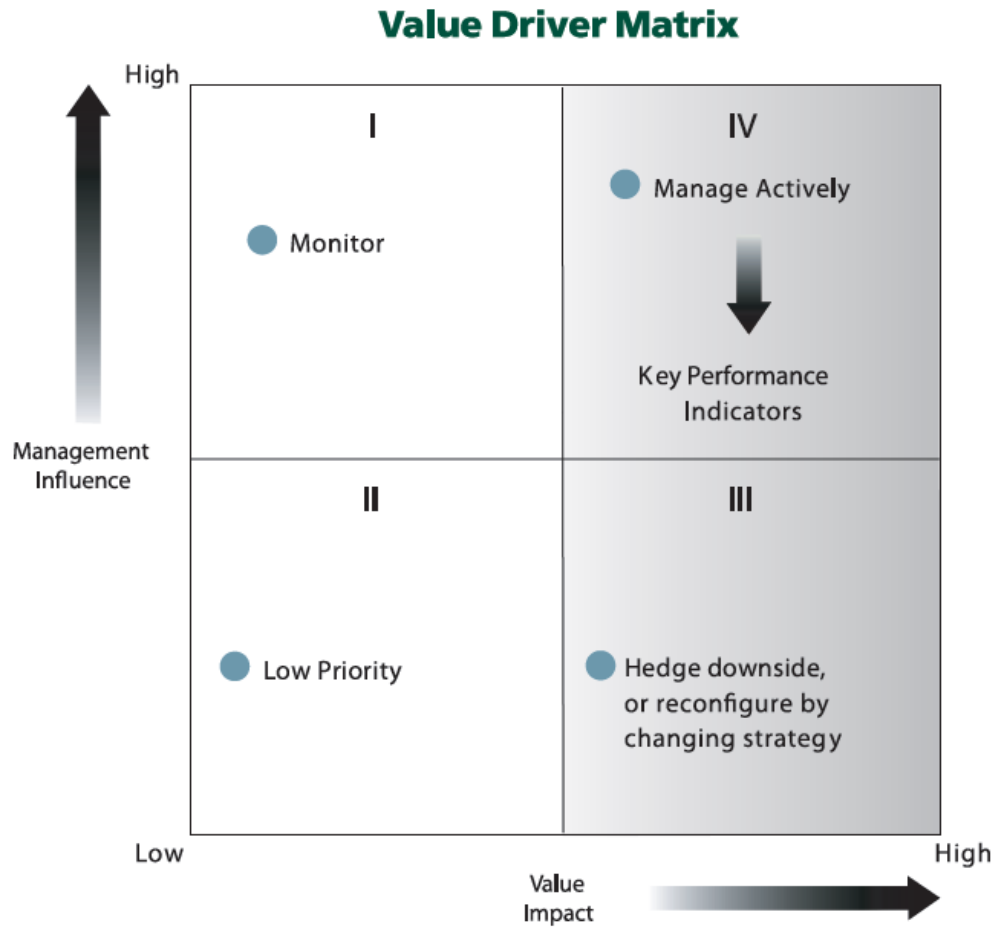


Figure 2.1 : Value driver matrix for prioritising value drivers
Source: L.E.K. Consulting (nd)

From this figure it can be seen that management must focus on and manage the drivers with highest impact on value, giving less priority to those which are of lower impact or which they have less influence over. These high priority drivers should be considered key value drivers and should form part of management's key performance indicators (KPI's). As such, this study focused on determining those value drivers which have the highest value impact

One important distinction that must be made which is specific to mining companies is company valuation versus mineral asset valuation. Mineral asset valuation is used to determine the value of a specific resource or operation and are used by mining companies to ascertain the value of their assets for impairment test, annual audits or investor corporate communications (Deloitte, 2016a). Njowa *et al.* (2013) described ongoing work from the late 2000's to develop a globally accepted mineral asset valuation template, rather than having individual regional codes. This is in an attempt to harmonise the three current major codes being:

- The Code for the Technical Assessment and Valuation of Mineral and Petroleum Assets and Securities for Independent Expert Reports (The VALMIN Code) for Australasia;
- The Standards and Guidelines for Valuation of Mineral Properties (The CIMVAL Code) for Canada; and
- The South African Code for the Reporting of Mineral Asset Valuation (The SAMVAL Code, 2016) for South Africa.

Each of these codes provides guidelines for the valuation of mineral assets depending on the stage of development of the project. As an example SAMVAL (2016) sets out the minimum standards and guidelines for reporting of mineral asset valuations in South Africa. This paper suggests that in the extractive industries, value is usually derived from an assessment of the intrinsic value of the unique technical characteristics of the asset. As such, it suggests that of three

recommended valuation approaches, being income, market and cost approaches, two valuation approaches should be used to assess the value of a mineral asset. However, as this research is reviewing changes to company value rather than resource or asset value, different mineral valuation techniques were not reviewed. Instead this research focussed on company value, with a range of valuation techniques available.

Accurate determination of the economic value of a company is difficult, with the calculation based on both buyer and seller perception of the company. For this reason a number of different valuation approaches have been developed, each with its own purpose and relevance, depending on the requirements of the valuation. NAVCA (2008) split the commonly used company valuation approaches into three categories being asset based approach, income approach and market approach. These three primary approaches each contain a number of different valuation methods.

2.2.1 Asset based valuation

Asset based valuation considers that the total value of a company can be determined by the difference between the company's assets and its liabilities. It is also referred to as balance sheet based valuation, since the balance sheet contains information on the company's assets and liabilities. In consideration of asset based valuation techniques, Fernàndez (2007) explained that whilst traditionally, company value lies in its balance sheet, generally the equity's asset value has little bearing on its market value. This is because this approach does not take into account the company's earnings, current industry situation and future potential earnings, as these do not appear on the balance sheet.

This is particularly relevant for mining companies where the primary assets are the individual mineral resources and mineral reserves which the company has title to. The market value of these, as determined by the mineral asset valuation

previously discussed, will not appear on the company's balance sheet. As such this asset based approach is not appropriate for mining company valuation.

2.2.2 Income based valuation

Income based valuation is based on the company's expected income streams rather than the balance sheet. This approach attempts to calculate all anticipated future earnings and economic benefits into a single amount. This includes metrics such as net present value, discounted cash flow and other future earnings valuation calculations. In reviewing the income based valuations, Steiger (2008) suggested that whilst these methods are a powerful tool for determining company value for capital budgeting, this approach is very vulnerable to changes in the underlying assumptions. Again, this is particularly relevant for the valuation of mining companies, where the calculation of future income streams is dependent on forecasting commodity prices, something which is a potential source of variability. The income approach is often used for the valuation of individual mineral assets, particularly as part of feasibility studies. However, to combine these individual valuations into a company valuation is difficult and as such not appropriate for this study.

2.2.3 Market based valuation

Market based valuation uses the concept that the value of a business is calculated by determining what an investor would be willing to pay for the company. For non-publically listed companies, or for the valuation of individual mining projects, this is done using market comparable methods. However SAMVAL (2016, p10), which provides guidelines on the valuation of a mineral asset, suggests that "the application of certain logic in Mineral Asset Valuation, such as 'gross in-situ value' simply determined from the product of the estimate of mineral content and commodity price(s), is considered unacceptable and inappropriate". As such it is often difficult to determine the properties used for value calculation. Ellis (2016)

researched how this comparable method can be used for mineral property valuation. In doing so, the research suggested that for mineral property interests there are a number of constraints in this method, specifically around identifying suitable properties for comparison. As such this was not considered as a valuation method for this study.

For many non-public (or private) and publically listed companies the market based valuation approaches involve the market capitalisation of the company. Whereas the asset and income based approaches attempt to calculate the intrinsic value of a company and can vary based on the input assumptions, the market valuation approaches give the value from the willing buyer, willing seller principle and requires that the monetary value obtainable from the sale of the company is determined as if in an arm's-length transaction (SAMVAL, 2016). This market value includes all underlying economic fundamentals, with investors considering the long-term potential of stocks to determine its value (Koller *et al*, 2005). As this research study is focused on analysing changes to company value over time, the more simplistic market valuation approach is therefore used in this study. This approach is more transparent, allowing the value estimated for a mining company to be benchmarked against other companies (Roberts, 2006).

The market value of a company is measured in two main ways. The simplest way is to calculate its market capitalisation, which is a multiple of the share price and the total number of outstanding shares. However, this calculation omits a number of important aspects which contribute to the overall value of a company, including debt, cash and cash equivalents. Bhullar & Bhatnagar (2013) suggested that a more appropriate measure of company value is enterprise value (EV), which provides a measure of the real market value of a firm as a whole business. As such, EV was used in this research study as the measure of company value and performance over the period under review.

2.3 Enterprise value and its potential drivers

Enterprise value is commonly defined as the equity value plus total debt, preferred stock and minority interest, minus cash and cash equivalents (Investopedia, 2016b). An alternate calculation for EV is the sum of the company's market capitalisation and its net debt. This is essentially the theoretical takeover price to buy out an entire public company, giving a much clearer picture of real value compared to market capitalisation.

The equity value of a company is calculated from its market capitalisation. This is the value of the company's outstanding or issued shares which is calculated by multiplying the current share price by the number of outstanding shares. Net debt is the total short and long term debt, minus any cash and cash equivalents. The reason for including any cash and cash equivalents is that these could theoretically be offset against any debt commitments. These calculations were used to calculate the EV of the selected companies, at different points in time, which represents changes in company value.

There are several factors which drive the EV of mining companies. Bhullar & Bhatnagar (2013) provided similar guidelines, suggesting that EV can be improved by three methods: increasing sales, reducing costs and reducing capital lockup. Supporting this, Deloitte (2012) suggested that the most common value drivers can be depicted as drivers of shareholder value as shown in Figure 2.2.

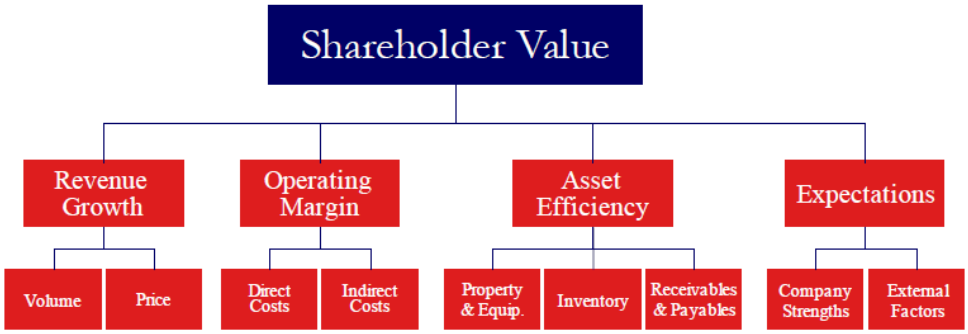


Figure 2.2 : High level shareholder value map
Source: Deloitte (2012)

Based on these guidelines, a number of different metrics were selected for analysis as drivers of company value. Revenue growth was analysed in terms of volume and price. Operating margin was analysed using valuation multiples which "attempt to capture many of a firm's operating and financial characteristics" (Macabacus, 2016, p1). This is particularly important for mining companies, which following the boom times experienced reduced profits as they struggled to get escalating costs under control. Asset efficiency, referred to in this report as capital efficiency, analyses how well a company uses its debt and equity portions to add company value. Analysis of expectations, in terms of company strengths and external factors, is much more difficult to correlate to EV as single metrics. As such, specific analysis of this was excluded from this study. However, where relevant links to expectations were identified and are discussed in this report.

2.3.1 Revenue drivers

The basic calculation of revenue is price multiplied by quantity of product sold (volume). For the mining industry, this is commodity production output multiplied by commodity price. Thus, the two potential drivers for revenue for mining companies is commodity price and production output.

Commodity price

The most obvious value driver of a mining stock is the price of the commodities produced, particularly for established mining companies (Maverick, 2015). However, Baurens (2010) identified that the valuation of mining companies is complicated because of the cyclical nature of commodity prices and that commodity companies are mostly price takers. This is because most minerals, excluding as an example diamonds, are fungible meaning that they can be mutually substituted. This means that unlike most industries where producers can influence the price of their products by changing quality or output, mineral commodity prices are dictated in the open market. As such the resulting valuation varies depending on where in the price cycle that company's output is.

For this reason it is important to understand the commodity price cycle for the period under review from 2006 to 2015. The start of the 21st century saw the end of the technology boom, but the start of the mining boom. The bursting of the 'dot-com' boom resulted in the 2001 US stock market crash. Up until the 2000s, commodity prices have been declining since a peak in 1974 as shown in Figure 2.3.

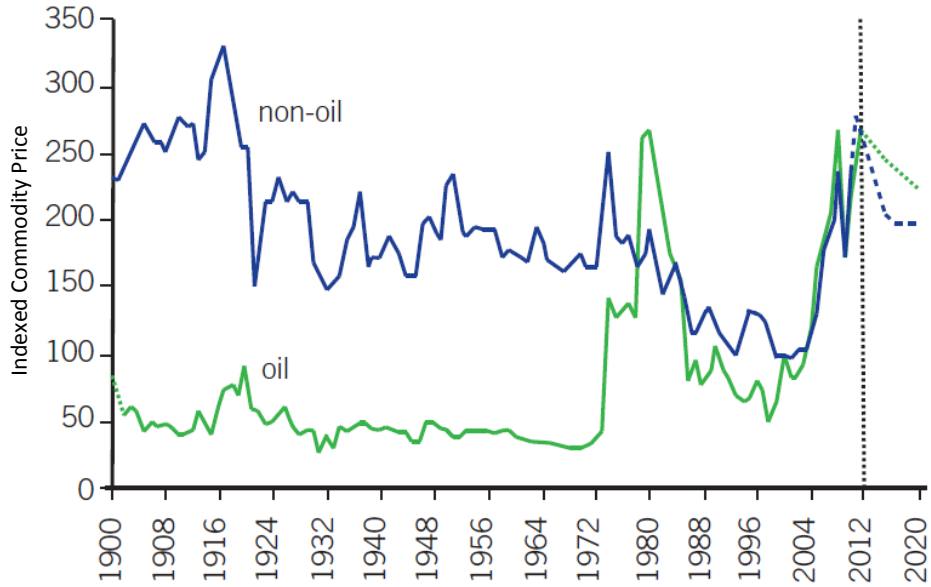


Figure 2.3 : Commodity prices in real terms (1900 – 2020)
Source: Brahmbhatt and Canuto (2010)

As of 2000 non-oil commodity prices were at their lowest levels in real terms for the entire century. However, this was all to change very quickly, with the rapid urbanisation and industrialisation of emerging economies, particularly those of China and India. This increased demand for most commodities, linked with limited supply, resulted in extraordinary increases in commodity prices. As can be seen in Figure 2.3, from the start of the boom in 2001 to the onset of the GFC in late 2008, commodity prices increased by over 250%.

Thus by 2006, the start of the analysis period for this study, the boom in commodity prices was well underway. Mining companies were continuously beating previous year revenue and profit outputs, and paying out growing dividends to investors. The majors were constantly on the lookout for opportunities to expand and increase production, in many cases with little consideration of the costs of such expansions. Price Waterhouse Coopers annually produce a mining publication which reviews global trends of the mining industry for the previous year. This is primarily done by reviewing the performance of the top 40 mining companies and gives a very good picture of the changing industry and commodity cycles over the period. The titles of these reports convey the sentiment of the period with the 2006 publication titled "*Let the good times roll*" (Price Waterhouse Coopers, 2006). In 2006, they reported that net profits for the top 40 mining companies were 1423% higher than the 2002 equivalent (Price Waterhouse Coopers, 2007).

Nevertheless this was all about to change drastically in 2008, with the onset of the GFC. In April 2008 the US government had to bail out two major financial institutions as a result of a sub-prime mortgage crisis. "Like a pack of dominoes, most banks with large sub-prime exposures joined the solvency and liquidity fracas" (Baxter, 2009, p106). As a result of this, for some commodities in a space of a couple of months, prices crashed to close to pre-boom times. Figure 2.4 shows this crash charting indexed average annual commodity prices with the spot price as of the end of 2008 shown at the end. As a result, in 2008 the market

capitalisation of the top 40 mining companies decreased by 62% (Price Waterhouse Coopers, 2009).

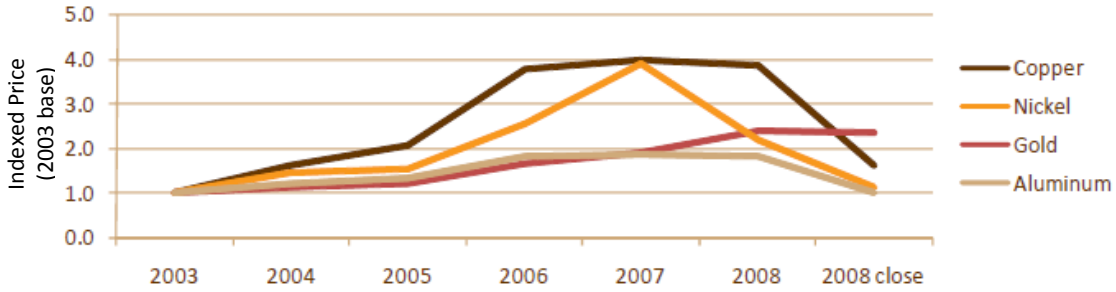


Figure 2.4 : Commodity prices indexed to 2003
Source: Price Waterhouse Coopers (2009)

In late 2009 and early 2010, the price of most commodities recovered to above pre-GFC levels and as such most companies started to recover to similar levels. This was relatively short lived, with the price of most commodities on a steady decline since the start of 2011 to the end of 2015, as shown in Figure 2.5. As a result, these years have been tough for mining companies with reduced demand pushing prices down and companies battling with the legacy of escalating cost bases from the boom times.

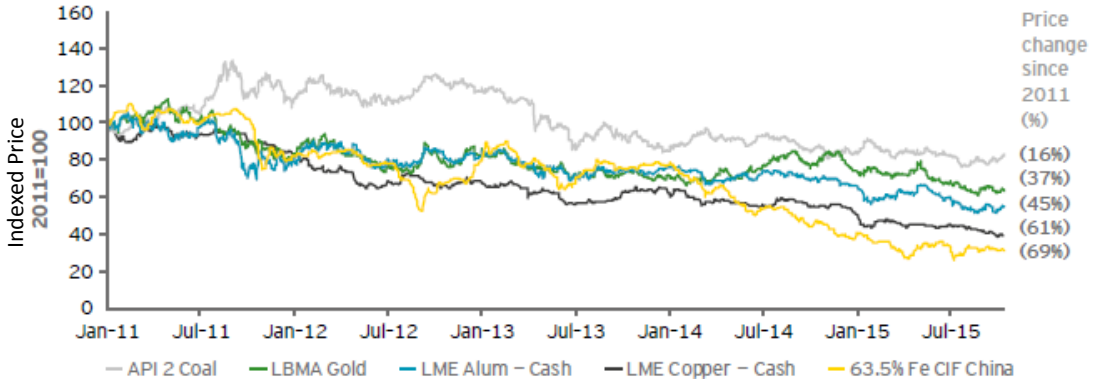


Figure 2.5 : Changes in key commodity prices since January 2011
Source: Ernst & Young (2015)

Given the variable performance between mining companies, commodity price cannot be the sole driver of mining company value. Widespread evidence exists to show that the rise and fall of company value is not just linked to commodity prices. For example, the market capitalisation of the top 40 mining companies dropped by 37% in 2015, which is disproportionately greater than that of commodity prices (Price Waterhouse Coopers, 2016). The same is apparent in times of rising prices, for example for the first 6 months of 2016, the gold bullion price rose by 27.7% yet the gold equities, as displayed by the FTSE Gold Mine Index, increased by 110.4% (FTSE Russell, 2016). Given this, there are obviously other factors that affect company value.

In most cases a mining company's revenue is as volatile as the price of the commodities it is producing. This is because revenue is a direct multiple of price and production output. As such both the commodity price and the production output determine company revenue and in combination were included as part of the analysis.

Production output

Whilst companies have very little control over commodity prices, they can influence how much they produce of each commodity. As commodity prices started to increase in the early 2000s, the main focus for mining CEO's moved from cutting costs and operational efficiency to "mine supply and maximising production" (Price Waterhouse Coopers, 2006, p3). However, the mining industry is unique to other industries in that mining projects have long lead times. As such companies cannot react to increased demand by quickly bringing on additional capacity. Consequently, the production output across the industry has been relatively flat. Table 2.1 shows the annual change in production output for the top 40 mining companies from 2007 to 2011.

Table 2.1: Year on year change in production output – top 40 mining companies
Sources: Price Waterhouse Coopers (2009, 2010, 2011, 2012)

	2007	2008	2009	2010	2011	Average
Gold	9%	-8%	7%	2%	9%	4%
Platinum	-9%	0%	-4%	0%	2%	-2%
Copper	4%	1%	0%	-4%	16%	3%
Zinc	11%	2%	9%	0%	-10%	2%
Coal	6%	4%	-2%	1%	-1%	2%
Iron Ore	7%	7%	-3%	16%	6%	7%
Nickel	8%	-1%	-11%	4%	13%	3%

As can be seen whilst in some years there are relatively large jumps in production output, in general output is relatively flat for the mining industry. Thus, the primary way mining companies increase production output is through acquisition of other companies and operations. As such, changes in production output for each of the major mining companies was analysed as this affects total revenue of the group.

2.3.2 Valuation multiples

Krinks *et al.* (2011) analysed the performance of 37 top mining companies to understand where they created greatest returns for shareholders from 1999 to 2009. Their research study indicated that increases in valuation multiples was a major contributor to strong shareholder returns. Their study included valuation multiples of earnings before interest, tax, depreciation and amortisation (EBITDA) multiple and EBITDA margin. The EBITDA multiple is defined as EV divided by EBITDA. Bhullar & Bhatnagar (2013) suggested that EBITDA multiple is a preferred valuation multiple to price on equity (P/E) as it considers debt and cash position, but excludes potential tax differences. Loughran & Wellman (2010) provided evidence on the link between enterprise multiples, which are valuation multiples and stock returns, and as such should be linked to company performance.

The second valuation multiple, EBITDA margin, is the EBITDA divided by total revenue. This shows what portion of revenue is earnings and what portion is operating expenses. Essentially this measure can be used to analyse which companies have managed to keep costs in line with changes in revenue and which have been most affected by escalating costs. In 2012 the net profit of the top 40 mining companies was down by 49% on the previous year (Price Waterhouse Coopers, 2013). Most companies bulked up when prices were high, focusing on expansion at all costs, and as softer commodity prices hit, the high costs remained eroding operating profits. Price Waterhouse Cooper (2015) described the importance of cost reduction for company value, highlighting how many companies lost cost efficiency, which is potentially destroying company value.

2.3.3 Capital management and efficiency

Capital management and efficiency can be defined as "the prudent management of the capital required to support a business and the use of the resulting free cash flows" (Krinks *et al*, 2011, p19). The authors further said that a large percentage of the total shareholder returns for mining companies from 1999 to 2009 can be attributed to effective and efficient capital management. Further to this, Deloitte (2016b) provided details of the top 10 issues facing mining companies going forward. One of the issues they discussed is industry debt burdens, which had "spiralled out of control" having a major effect on the value of a company. By 2015, net debt ratios for the top 40 mining companies had risen to the highest levels since the early 2000s and leverage was increasingly stretching the balance sheets of many of the major mining houses (Ernst & Young, 2015). Whilst this is an industry-wide issue, the extent of the issue varies significantly among companies.

There are three common measures of capital efficiency being gearing ratio, net debt to EBITDA and return on capital employed (ROCE). Gearing ratio is a measure of a portion of the company's assets (debt plus equity) which is debt. Examining

this can provide an indication of the company's financial strength, gauging the capacity of corporates to absorb unexpected financial shocks (Ernst & Young, 2015). In general, if the gearing ratio is too high, it is a sign that a company may be in financial distress and unable to pay debtors. Increasing gearing means the financial risk associated with that company is also increasing.

The second capital management measure which is commonly used, and suggested by Price Waterhouse Coopers (2016) as a convent applied by lenders is the net debt to EBITDA. The same report suggested that ratios above four should cause alarm to management and investors and as a benchmark the 2014 and 2015 averages across the top 40 mining companies were 1.52 and 2.46, respectively. Net debt to EBITDA is an important measure as it shows the company's ability to pay back its debt. The higher the number, the more difficult it could be for the company to pay off its debt, or be able to take on any additional debt required to grow the business. As this figure is essentially a measure of how many years EBITDA is required to pay off the company's debt, this value must only be reviewed on an annual year-end basis. As can be seen in Figure 2.6, which shows the above measures for 88 listed mining companies, both of these values increased significantly over the 15 year period from 2000 to 2014, potentially indicating a major driver to company value over the period.

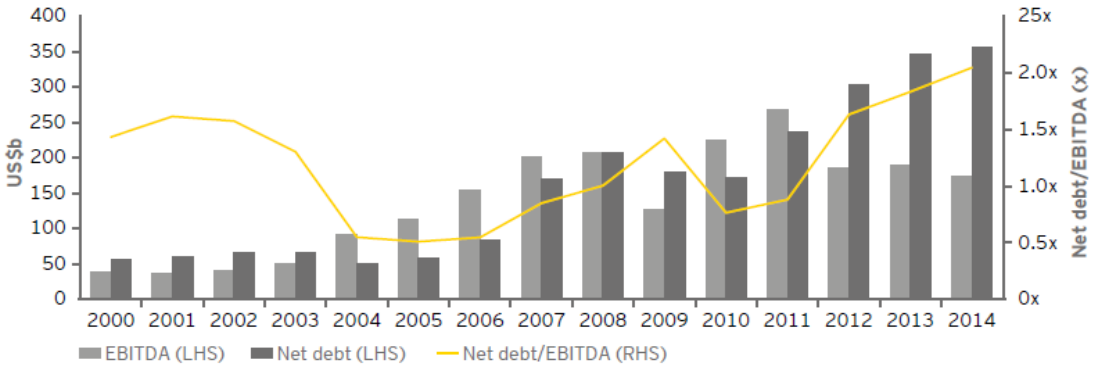


Figure 2.6 : Growing net debt in the mining industry – analysis of 88 listed mining companies

Source: Ernst & Young (2015)

The third capital management value driver is ROCE. ROCE is a measure of the company's profitability compared to the capital employed to achieve this profit. This is calculated by dividing the earnings before interest and tax (EBIT) by the capital employed. The capital employed is commonly defined as the total assets less the current liabilities. The higher the ROCE, the more efficient the company's use of available capital. It has been proven that the market rewards firms that can get good returns on the capital they employ in their business, by valuing them at a higher premium than their peers (Pattabiraman, 2013). ROCE is particularly useful when comparing performance of companies in capital intensive industries (Damodaran, 2007), something which the mining industry most definitely is. As a benchmark for the mining industry, when Mark Cutifani joined Anglo American as the CEO in 2013 he committed to achieving a ROCE of 15%, however with declining commodity prices this target has slipped to a range between 5 – 15% between 2013 and 2016 (Wilson, 2016).

2.4 Chapter summary

This chapter has introduced the theory of company value. In order to determine the company value a number of different valuation approaches are used including the asset based approach, income approach and market approach. For the purpose of this study the market based approach was considered the most appropriate because of its limited reliance on input assumptions and its suitability for comparing companies. Within this approach, existing literature suggests that the most appropriate measure of company value is EV. Research also shows that sales, costs and capital lockup are the main drivers of EV. These can be reclassified into three main categories: revenue drivers, valuation multiples and capital management and efficiency drivers. The main drivers of revenue were identified as commodity price and production output. EBITDA multiple and EBITDA margin are the two main valuation multiple drivers. Finally, gearing ratio, net debt to EBITDA and ROCE are the main capital efficiency drivers. All of these drivers

ultimately influence the EV of companies and were therefore selected as the value drivers for this research study.

3 RESEARCH METHOD

3.1 Chapter overview

This chapter discusses the research methods and analytical techniques used. The data required to calculate EV and identified potential value drivers was obtained from the public domain using company annual reports, half yearly reports and quarterly production reports. Where the required values were not directly reported they were estimated from available data. All measures were indexed back to the 31st December 2005. The final date for analysis was the 31st December 2015 which represents a 10 year period and the position of the company as of the start of 2016.

3.2 Data that was analysed and its sources

3.2.1 Enterprise value

As mentioned in the literature review, EV was used as the measure of company value for this study. EV was not specifically reported in the annual financials by any of the companies, so it was calculated from reported metrics. As previously defined, EV can be calculated as net debt plus market capitalisation. Net debt was reported by some companies, but in cases where it was not reported it was calculated as the sum of both short and long term debt minus cash and cash equivalents. Market capitalisation is the current share price multiplied by the number of issued shares at the end of the period. The current share price as of the close of each period was sourced from Yahoo Finance for each company (Yahoo Finance, 2016a – d). The total number of shares issued and outstanding is reported as part of the changes in stockholders equity in both annual and semi-annual reports. For all companies the share prices from the primary listing was used, being:

- Anglo American - London Stock Exchange;
- BHP Billiton - Australian Stock Exchange;
- Rio Tinto - London Stock Exchange; and
- CVRD-Vale - New York Stock Exchange.

As the reporting currency for all companies is United States Dollars (USD), those stocks that are reported in Great British Pounds (GBP) and Australian Dollars (AUD) were converted to USD using the month average exchange rate for that currency. These exchange rates were sourced on a monthly average from FXtop (2016) for the period from January 2006 to December 2015. EV was calculated on a 6 month interval and indexed back to the 31st December 2005.

Whilst share price is one of the main derivatives of EV, specific analysis of the drivers of share price were not included in this study. Instead the focus was on the main economic drivers of EV, of which share price is a subset.

3.2.2 Production output

The two primary drivers which were analysed for their effect on revenue was production output and commodity price. An increase or decrease of production output across all commodities, should show the growth or contraction of a company respectively. In order to analyse this, the quarterly production output for each of the primary commodities segments was indexed to the quarterly production for the last quarter of 2005. This was compared to the indexed EV for the same period, in order to identify trends. Thus, if a company is producing seven main commodities in Quarter 4 (Q4) 2005, then the indexed output for the start of the analysis is seven. Each commodity is then indexed quarter on quarter back to Q4 2005 output and plotted on a stacked area graph. A hypothetical example of this calculation is shown in Table 3.1 and then plotted in Figure 3.1.

Table 3.1: Hypothetical production output and indexing

	Q4 2005		Q1 2006		Q2 2006		Q3 2006	
	Production	Indexed	Production	Indexed	Production	Indexed	Production	Indexed
Gold	900 (oz)	1	1200 (oz)	1.3	700 (oz)	0.8	500 (oz)	0.6
Coal	25 (Mt)	1	15 (Mt)	0.6	20 (Mt)	0.8	30 (Mt)	1.2
Copper	200,000 (t)	1	400,000 (t)	2.0	300,000 (t)	1.5	300,000 (t)	1.5
Iron Ore	7 (Mt)	1	7 (Mt)	1.0	8 (Mt)	1.1	3 (Mt)	0.4

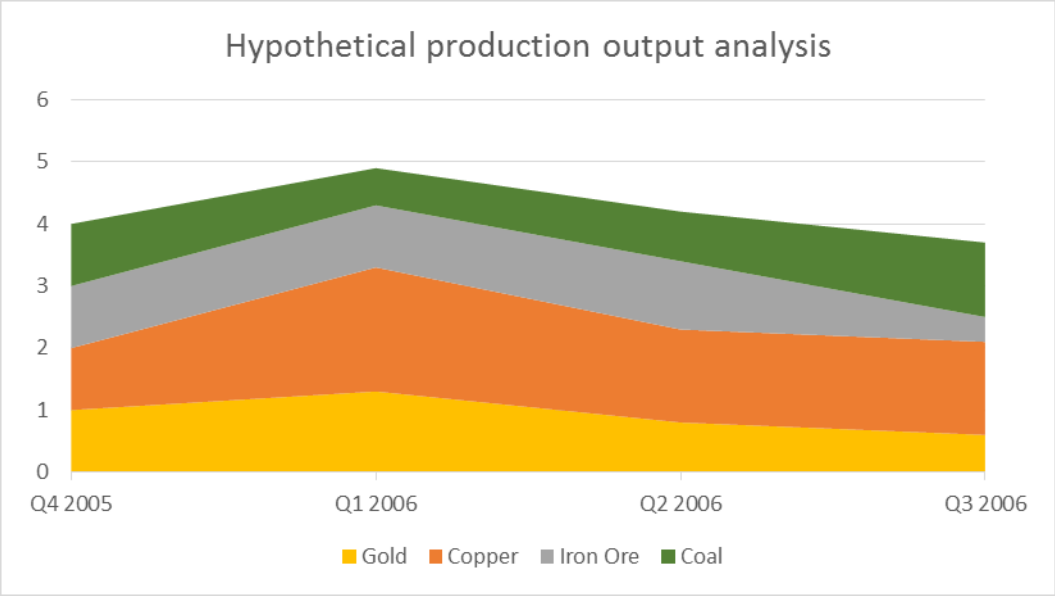


Figure 3.1 : Stacked area graph of hypothetical production output

In Figure 3.1 the company was producing from four commodity segments represented by gold, coal, copper and iron ore. As an example of the analysis that could occur on this data:

- Gold output for the first quarter of 2006 increased, however for the next two periods it decreased to eventually be almost half the production of Q4 2005;
- Coal output reduced, then started to increase by Q3 2006;
- Copper output increased substantially throughout all periods;
- Iron ore remained relatively flat with a big drop in output for Q3 2006; and
- Total commodity output increased in early 2006 but decreased by Q3 2006.

This trend was then plotted against EV to see if changes in production output drove company value. In order to consider both commodity price and production output for each of the companies, both were indexed to Q4 2005 in order to analyse any trends. However, in the case of CVRD-Vale, which expanded its business to include additional commodity segments after 2005, indexing all production output back to Q4 2005 was not possible. Thus it was indexed to the first quarter (Q1, 2010) where it produced the full range of commodity segments. The same analysis to EV was done.

The production per commodity for each company was available from the quarterly production reports. Since the analysis of production output and commodity prices starts with the revenue contribution for each commodity from 2005, commodities were grouped together as per the company segments. Appendix 7.1 to Appendix 7.4 provide a summary of how each company has broken down various commodities into segments. As some segments include a basket of different commodities, the primary commodity or commodity which contributed the most to segment revenue was selected for production and pricing analysis. Where no commodity is produced, for example in the "other" segment, no production analysis was done. Table 3.2 summarises the different segments for each company, detailing the primary commodity, which was analysed for changes in production output.

All production values were indexed back to the Q4 2005 output. However, to ensure that this quarter was not abnormal and did not misrepresent the changes in production output, the total production for 2005 for each commodity was divided by four to get the average quarterly production for 2005.

Table 3.2 : Summary of primary commodity analysed per company sector

Company	Segment	Primary commodity analysed
Anglo American	Platinum	Refined platinum
	Gold	Gold
	Diamonds	Diamonds
	Coal	Total coal
	Copper	Copper
	Nickel, niobium & mineral sands	Nickel
	Iron ore & manganese	Total iron ore including lump and fines
	Other mining, industrial & corporate	No analysis
BHP Billiton	Petroleum & potash	Total petroleum
	Aluminium, manganese & nickel	Aluminium
	Base metals	Copper
	Diamonds and speciality productions	Diamonds
	Iron ore	Iron ore
	Metallurgical coal	Metallurgical coal
	Energy coal	Energy (thermal) coal
Rio Tinto	Aluminium	Aluminium
	Iron ore	Iron ore
	Diamonds & industrial minerals	Titanium dioxide
	Copper	Copper
	Energy	Thermal coal
CVRD-Vale	Ferrous metals	Iron ore
	Coal	Thermal coal
	Base metals	Nickel
	Copper	Copper
	Fertilizers	Phosphate rock
	Aluminium	Bauxite
	Logistics & others	No analysis

3.2.3 Commodity prices

The second driver for revenue alongside production is the commodity price. The specific commodity price for each of the company segments is analysed in the revenue analysis. A more general analysis, using the trends of all the major commodities was undertaken to determine if there was any link to EV. This looked at the different baskets of commodities, all indexed back to the average price in 2005. The majority of commodity prices were collected from the World Bank

commodity price “pink sheet” (World Bank, 2016). This data file included prices for the following:

- Copper –$/metric tonne;
- Nickel - $/metric tonne;
- Aluminium - $/metric tonne;
- Platinum - $/troy ounce;
- Gold - $/troy ounce;
- Iron ore - $/dry metric tonne unit (dmtu). The cost and freight (cfr) price was used which means that the seller arranges for sea carriage of the product to the required port. Since indexed pricing is being used, then this price is suitable for all companies;
- Phosphate rock - $/metric tonne;
- Thermal coal – $/metric tonne. Two different prices are provided for thermal coal being Australia and South Africa. The Australian price is a free on board (FOB) price to Newcastle & Port Kembla. For South Africa it is FOB to Richards Bay Coal Terminal (RBCT). The Australian coal is of a slightly higher energy rating and as such attracts a slightly higher price. Both prices track fairly closely and since the four companies analysed are exposed more to Australian production, the Australian thermal coal price was used; and
- Crude Oil - $/barrel ($/bbl). As reported by the World Bank the price is the equally weighted average of crude oil Brent, crude oil Dubai and crude oil US West Texas Intermediate (WTI).

The World Bank only reports thermal coal prices however as many of the mining companies also produce metallurgical/coking coal this price was also required for the analysis. Since the majority of the production of metallurgical/coking coal is from Australia, the hard coking coal (HCC) spot FOB Australia price was used. This

is the hard coking coal, free on board price and available from The Steel Index (2016).

Due to the specific nature of the diamond industry, diamond prices are not reported on the World Bank report or on commodity pricing forums. This is because diamonds are not traded as a bulk commodity and that they are non-fungible which means no two diamond carats are the same. As such their price is dependent on the unique characteristics of each stone as characterised by the four c's being colour, clarity, cut and carats. Thus, for the purpose of this analysis, the diamond pricing trends index was used. This index, published by a group called the Diamond Search Engine, is a representation of the current market pricing for diamonds. This is the average retail price per carat of loose diamonds from jewellers around the world (DiamondsSearchEngine, 2016). Whilst this is not the realised price that the mining company would have received for the diamonds produced, it should represent the trends in changes in pricing which is appropriate when indexing back to the Q4 2005 pricing.

3.2.4 Revenue

To measure how changes to both commodity price and commodity production output would have affected revenue on a quarter by quarter basis the following measures were developed:

1) Calculate the percentage that each commodity segment contributed to revenue for 2005 for each company (or in the case of CVRD-Vale 2010). This is calculated by taking the total reported revenue for that sector and dividing by the total revenue for the company. For example platinum 11%, gold 8%, etc.;
2) Calculate the indexed average quarterly commodity price compared to Q4 of 2005 (or in the case of CVRD-Vale Q1 2010); and
3) Multiply the percentage revenue by the indexed production by the indexed commodity price.

This output represents the estimated changes to revenue through changes in commodity price and production. A hypothetical example of this calculation, using hypothetical data, is shown in Table 3.3 and Table 3.4.

Table 3.3 : Hypothetical price and production data

	2005 Revenue	2005 Q4 Commodity price	2006 Q1 Commodity price	2005 Q4 Production	2006 Q1 Production
Gold	$US25M	$ 478	$ 591	1,500	1,500
Copper	$US25M	$ 1.90	$ 2.76	150,000	100,000
Platinum	$US25M	$ 944	$ 1,107	700	700
Iron Ore	$US25M	$ 69	$ 68	7.8	9.5

Table 3.4 : Hypothetical commodity price, production and revenue change

	% Revenue contribution	2006 Q1 Indexed commodity price	2006 Q1 Indexed production	2006 Q1 Theoretical indexed revenue
Gold	25%	1.24	1.00	31%
Copper	25%	1.45	0.67	24%
Platinum	25%	1.17	1.00	29%
Iron Ore	25%	0.99	1.22	30%
Total	100%			115%

As can be seen in Figure 3.2 through the hypothetical example above, the total revenue produced by the company should have increased. Copper, which had the greatest increase in price actually decreased in revenue due to reduced production. Iron ore had increased revenue however this was due to production rather than commodity price. The company could have had a much higher revenue by increasing production in those commodities where the price increased the most (gold and copper) and focused less on the commodities where the price remained relatively flat or decreased (iron ore).

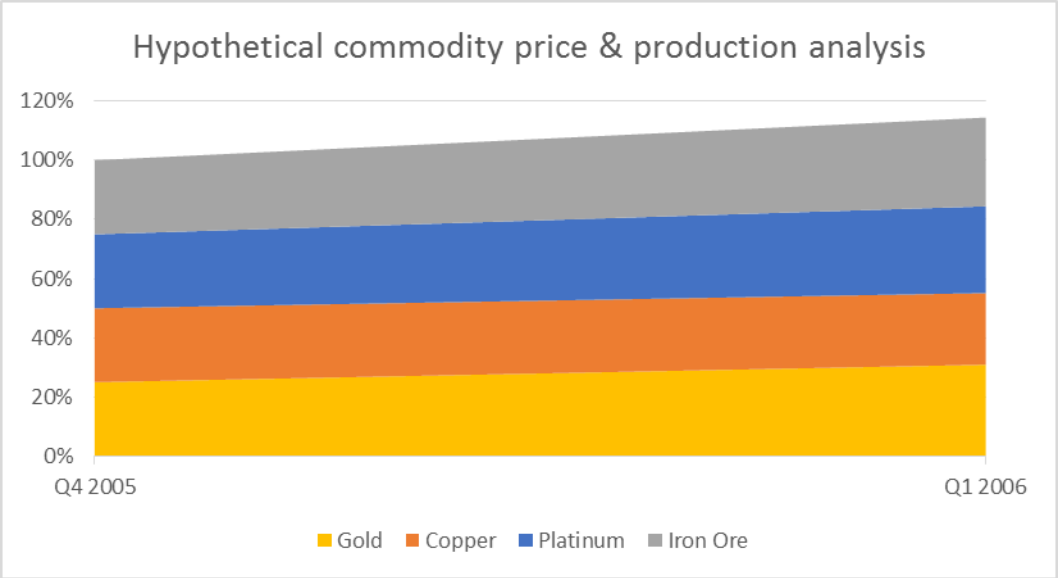


Figure 3.2 : Hypothetical commodity price and production analysis

Where a company had significant revenue contribution from non-commodity sectors, for example CVRD-Vale's logistics business, the annual percentage contribution to revenue was extracted from the annual financial reports and this figure was used for each quarter of the year.

3.2.5 Valuation multiples

The two valuation multiples which were analysed were EBITDA multiple and EBITDA margin. EBITDA was reported by all companies on both an annual and semi-annual basis. EBITDA multiple is measured on an annual basis by dividing the year-end EV by the total 12 month EBITDA. EBITDA margin is a comparison of revenue to EBITDA and as such it can be measured on a semi-annual basis for a 6 month period. Since all companies report EBITDA and revenue in their annual reports for a period of 12 months, the first half results were subtracted from the full year results to get the second half value. Both values were plotted against EV to determine if there was any correlation as a driver for company value.

All the required financial data was collected from company annual and interim reports. Where the required value was not directly reported, it was estimated through calculations based on other available data. All companies report annual

results which cover the period of 12 months and interim results which cover the first 6 months of the year. For EBITDA margin, which is measured semi-annually, the second quarter EBITDA was calculated by taking the annual results and subtracting the first half yearly EBITDA. This was the same approach used for the revenue calculation.

3.2.6 Capital management and efficiency

The three capital management and efficiency drivers analysed were gearing ratio, debt to EBITDA and ROCE. In the first two calculations, debt is the numerator. For this study since EV is being used as the value measure and uses net debt rather than gross debt, net debt was used for all calculations. Net debt is either reported in the annual reports on the balance sheet or was calculated by subtracting all cash and cash equivalents from gross debt.

Gearing ratio is calculated by dividing net debt by total capital. In some annual and interim reports companies reported gearing ratios. Where it was not reported it was calculated by dividing the net debt by the total capital. Total capital is calculated by adding the net debt and the equity attributable to shareholders. The gearing ratio was calculated on a semi-annual basis.

Debt to EBITDA is a company's ability to pay off debt and is a comparative measure of the approximate number of years it would take a company to pay off all its debt. As such this should only be measured annually, using the full year's earnings. EBITDA was reported by all companies in their annual reports.

Finally, ROCE is a measure of the efficiency of a company's assets to generate profit. As such it is calculated by dividing the company's EBIT by the capital employed. EBIT is reported on company reports often as operating profit, and shows the company profits generated from operations. It can also be derived from net income by adding back interest and taxes. Capital employed refers to the total assets of a company less any current liabilities, both of which are reported on the

company's balance sheet. Whilst many companies report ROCE on their interim results, the EBIT for the period is annualised or based on the full previous 12 months performance data (Anglo American, 2016b). As such ROCE was calculated annually.

3.2.7 Potential value drivers

In summary Table 3.5 shows the value drivers analysed to determine the key drivers for mining company EV. Data on each of these was collected for the four mining companies to determine which one had the biggest influence on company value.

Table 3.5 : Summary of potential value drivers

Production output	Quarterly change in production output for each commodity since Q4 2005. Measured quarterly.
Commodity Price	Grouped baskets of similar commodities. Measured monthly.
Commodity exposure	Combination of production output change and commodity price to estimate revenue change since Q4 2005. Measured quarterly.
EBITDA multiple	A measure of EV to EBITDA. Measures the value of the company compared to earnings. Measured annually.
EBITDA margin	A measure of the EBITDA to revenue. Measures the portion of earnings which is profits compared to operating costs. Measured semi-annually.
Gearing ratio	Ratio of net debt to sum of debt plus equity. Measures the company financial strength. Measured semi-annually.
Debt to EBITDA	Net debt divided by EBITDA. Measures the company's ability to pay back debt. Measured annually.
Return on capital employed (ROCE)	EBIT divided by capital employed. It is a measure of efficiency of a company's use of available capital. Measured annually.

3.3 Data analysis process

All required data was collected and calculations were done to get the final outputs. All values were then indexed back to the Q4 2005 figure, in order to analyse and determine any trends and correlations between the potential value drivers and EV. For the production output and commodity price analysis a stacked area graph was used. For all other drivers linear graphs of both the possible value driver and EV were used as summarised in Table 3.6.

Table 3.6 : Summary of potential value drivers and analysis approaches

Potential value driver	Graph type	Correlation analysis possible
Production	Stacked area	No
Theoretical revenue	Stacked area (of %)	No
EBITDA multiple	Linear	Yes
EBITDA margin	Linear	Yes
Gearing ratio	Linear	Yes
Debt to EBITDA	Linear	Yes
Return on Capital Employed	Linear	Yes

From the stacked area graph, potential value drivers for each company were visually observed based on the trend of driver versus EV. For the linear graphs a correlation coefficient analysis using the Microsoft Excel Pearson functionality was done. The Pearson product-moment correlation coefficient is the most common method for determining a correlation between two variables. It is most relevant when analysing a linear relationship between variables, which all of the above should be. As summarised by Laerd Statistics (2016), the Pearson correlation coefficient, r, can be a range of values from -1 to +1. A value of 0 indicates no correlation between variables, with >0 a positive correlation and <0 a negative correlation. The closer the value is to +1 or -1, the stronger the correlation and thus, the relationship between the variables. The same reference suggests the guidelines when interpreting the Pearson correlation coefficient as per Table 3.7.

Table 3.7 : Pearson correlation guidelines
Source: Laerd Statistics (2016)

Strength of association	Pearson correlation value	
	Positive	Negative
Low	0.1 to 0.3	-0.1 to -0.3
Medium	0.3 to 0.5	-0.3 to -0.5
High	0.5 to 1.0	-0.5 to -1.0

As such the potential value drivers were analysed for correlation. Further to this, analysis and discussion was done for any significant changes in any of the value drivers, or where the drivers were at irregular levels. This formed part of the individual analysis and discussion of each company.

3.4 Chapter summary

A total of eight different potential value drivers were selected for analysis to review their influence on EV. These were split into three different categories being revenue drivers, valuations multiples and capital management and efficiency ratios. The required data for each company was collected from annual and interim financial reports and quarterly production reports. Commodity prices for the period of investigation were also collected. All data was then indexed back to Q4 2005 in order to be able to track trends and determine correlation between the different drivers and enterprise value. A statistical technique, the Pearson correlation coefficient, was then used to determine the strength of correlation between the value drivers and EV. All data is presented and analysed in the next chapter.

4 RESULTS AND ANALYSIS

4.1 Chapter overview

This chapter presents and analyses the results for company value and the different potential value drivers. EV is first analysed to identify the differing company performance over the period 2006 to 2015. Then each of the potential value drivers is presented and analysed, discussing both the correlation to EV and any trends between the different companies and possible effects on company value. Finally, considering all four companies, the key value drivers are selected and discussed.

4.2 Variation in company performance

Figure 4.1 shows a comparison of company value over the 10 year period from 2006 to 2015, highlighting the difference in performance for the four companies over this period. The figure shows EV for each of the companies, indexed to 31st December 2005 using data gathered from company reports shown in Appendix 7.5 to Appendix 7.8. CVRD-Vale was indexed to 30th June 2006 due to a share split in May 2006 which had a major effect on EV.

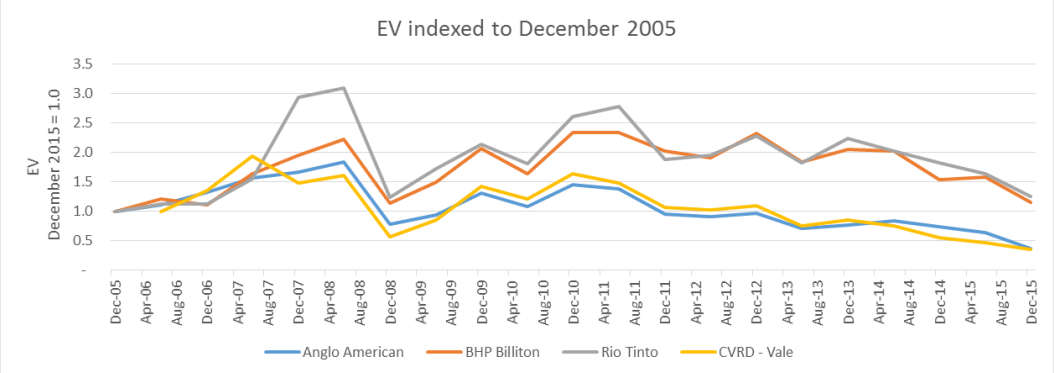


Figure 4.1 : Enterprise value for the four companies, 2006 – 2015
Sources : Anglo American (2006 – 2016), BHP Billiton (2005 – 2015), South 32 (2015), Rio Tinto (2006 – 2016a) & Vale (2006 – 2016)

It is clear from Figure 4.1 that of the four companies, BHP Billiton and Rio Tinto have performed significantly better than the other two over the 10 year period. From the graph it can be seen that the 10 years can be split into four distinct periods, primarily driven by price cycles as described in Section 2.3.1. The first period, from the start of 2006 to June 2008 was the tail end of the commodities boom which saw commodity prices rise to previously unseen levels. All four companies increased in value leading up to mid-2008 as the demand for commodities continued to push prices up. Between September 2007 and December 2008 Rio Tinto was by far the best performer increasing company value by almost three times from the start of 2006. This is in comparison to BHP Billiton which doubled in value and Anglo American and CVRD-Vale which were both around 50% higher over the same period. It appears that Rio Tinto's success over this period, something which is discussed later in this report, positioned it in good stead to be able to handle the drop in prices from June 2008.

Then came a six month period (from June 2008 to December 2008) of rapidly declining prices with the onset of the GFC. As a result of this Anglo American, Rio Tinto and CVRD-Vale were affected the most with a 60% drop in value, whereas BHP Billiton was closer to 50%. Given Rio Tinto's and BHP Billiton's higher bases from value added pre-GFC, this meant they returned to EV's on par with their 2006 level. Anglo American and CVRD-Vale were below their 2006 values. This differing performance is analysed and discussed later in this report.

This was followed by the recovery of prices and as such company value from December 2008 to December 2010. If the EV is rebased to December 2008 as shown in Figure 4.2, CVRD-Vale significantly outperformed the other companies to the end of 2010. BHP Billiton and Rio Tinto had very similar performance from 2008 through to the end of 2015, whilst Anglo American underperformed compared to its competitors during the same period.

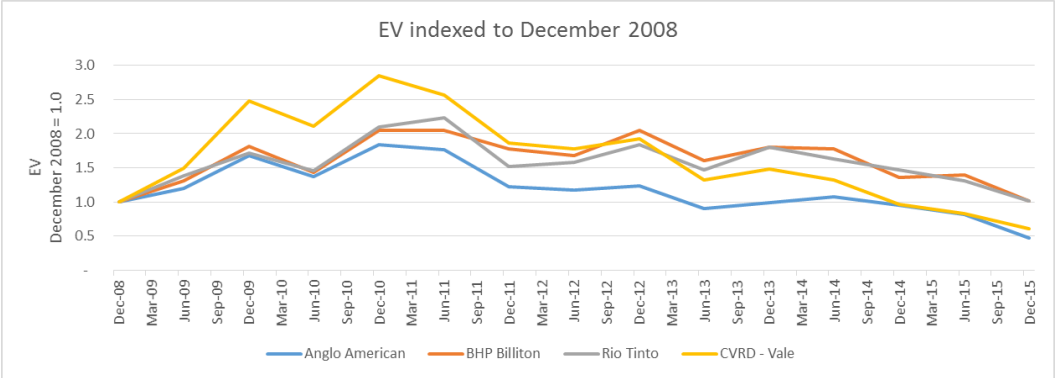


Figure 4.2 : Enterprise value for the four companies, 2008 – 2015
Sources : Anglo American (2009 – 2016), BHP Billiton (2008 – 2015),
South 32 (2015), Rio Tinto (2009 – 2016) & Vale (2009 – 2016)

The final period of analysis, from June 2011 to the end of 2015 saw declining EVs for all companies. It is this period which highlights a distinct difference between the companies which have increased in value from 2006 to 2015 and those which have lost value. By again changing the indexed period to June 2011, as shown in Figure 4.3, it is clear that BHP Billiton and Rio Tinto, which lost only 40% of their EVs, performed much better than Anglo American and CVRD-Vale which lost close to 60%.

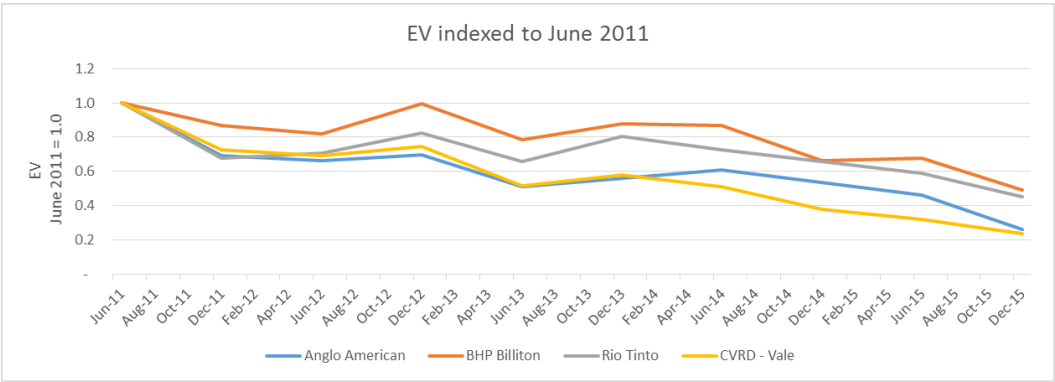


Figure 4.3 : Enterprise value for the four companies, 2011 – 2015
Sources : Anglo American (2012– 2016), BHP Billiton (2011 – 2015),
South 32 (2015), Rio Tinto (2012 – 2016) & Vale (2012 – 2016)

Analysis of EV for the four companies over the 10 year period has shown the following variable performance:

- Rio Tinto significantly outperformed the other companies from 2007 to 2008;
- Anglo American and CVRD-Vale underperformed from 2006 to 2008;
- BHP Billiton was the least affected by the 2008 onset of the GFC;
- CVRD-Vale had the best recovery of EV from 2008 to the end of 2010;
- Anglo American had the worst recovery of EV from 2008 to the end of 2010 and then a similar poor performance to end of 2015; and
- BHP Billiton and Rio Tinto significantly outperformed Anglo American and CVRD-Vale from mid-2011 to the end of 2015.

Explanation of this difference in performance done in later sections of this study should identify the key drivers for mining company value.

4.3 Production output

The production output for each company was plotted on a stacked area graph to show the cumulative output from the different commodity segments per quarter as shown in Figure 4.4 to Figure 4.7. The input data for these graphs is shown in Appendix 7.9 to Appendix 7.12 respectively. Each commodity segment is indexed back to Q4 2005, except for CVRD-Vale which only started producing from all commodity segments in March 2010, and as such is indexed to Q1 2010.

4.3.1 Anglo American's indexed production output

Figure 4.4 shows Anglo American's indexed production output using input data from Appendix 7.9. The company was producing from seven commodity segments ceasing gold production at the end of 2007 with the sale of AngloGold Ashanti as mentioned in Section 1.7.1.

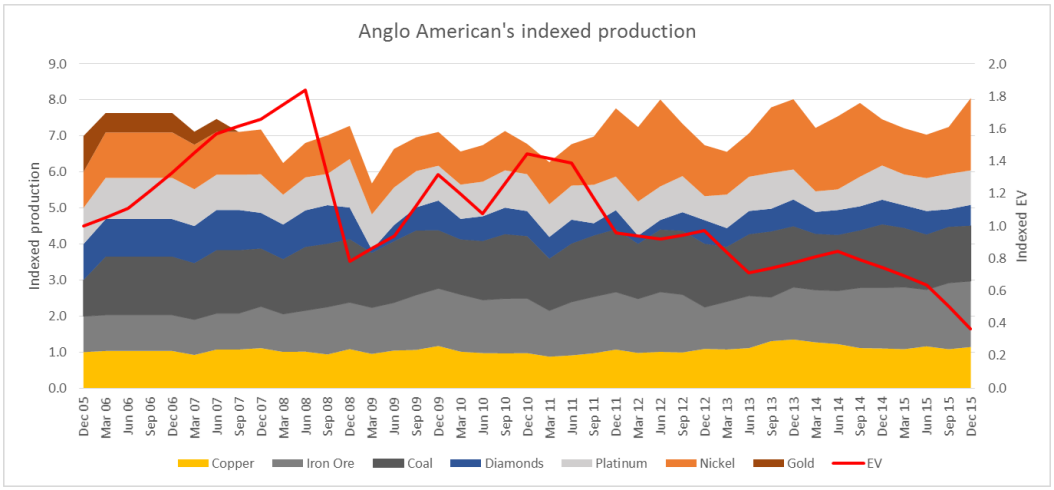


Figure 4.4 : Anglo American's indexed production and EV
Sources : Anglo American (2006 – 2016)

Throughout the 10 year period Anglo American's copper output remained relatively flat as the company maintained sustainable assets. Iron ore output increased by approximately 150% - 180% on the 2005 production as a result of increased output from the Kumba operations and ramping up of production from Minas Rio from late 2014. Coal output has remained relatively stable except at the start of 2011 due to severe flooding of operations in Australia. Platinum output has been relatively stable for the entire 10 year period, with only a major drop in output in Q1 and Q2 2014 where production dropped almost 40% as a result of a major strike action in the platinum sector. However, diamond production has been turbulent, with producers attempting to control prices by limiting supply when demand was low. As such production was reduced significantly as a result of lower demand in early 2009, only returning to 80% of the 2005 output and then dropping again in 2012 returning to 70% of the 2005 output. The year 2015 saw a steady drop in diamond production as demand and as such prices continued to fall. The company's base metal segment, represented by nickel production, had the biggest production increase almost doubling in output over the 10 year period. Thus for the calendar year 2015, in contrast to 10 years earlier, Anglo American produced approximately 10% more copper, 25%

more nickel, 70% more iron ore, 30% more coal but 10% less platinum and 40% less diamonds.

In comparing Anglo American's production output for each commodity sector against the company's EV, it would appear there is a weak correlation between the two. In fact, from 2012 as the company tried to react to decreasing prices by increasing production output, EV continued to decrease. This would suggest from the analysis of Anglo American, that production output is not a driver of EV.

4.3.2 BHP Billiton's indexed production output

Figure 4.5 shows the changes in production output for BHP Billiton, which like Anglo American was also producing from seven commodity segments. The input data for this figure is shown in Appendix 7.10.

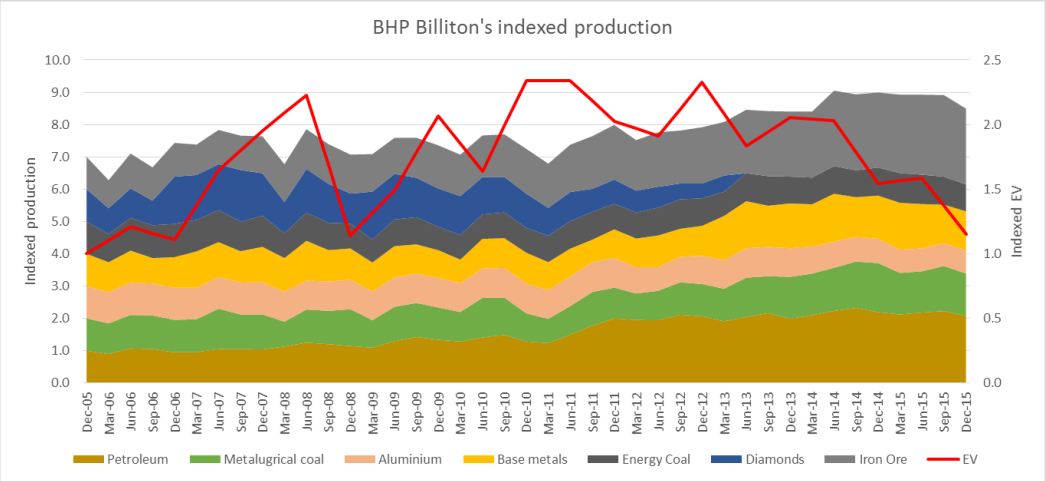


Figure 4.5 : BHP Billiton's indexed production and EV
Source : BHP Billiton (2005 – 2015) & South 32 (2015)

In contrast to Anglo American's production output, shown previously in Figure 4.4, it appears that BHP Billiton's production output has been much more stable and significantly grown in some commodity sectors. Unlike any of the other commodity companies, BHP Billiton has a large petroleum segment which has gradually grown over the 10 years to produce double the output in 2015 compared to 2005. Similarly BHP Billiton's base metal segment (represented by copper

output) and iron ore segments have also grown. Its base metal production was up by 25% at the end of the 10 year period, with its iron ore segment producing almost 250% of the 2005 output. Diamonds formed a small sector of BHP Billiton's business with declining production from mid-2010 to when the business was sold at the end of 2012. It is only the energy coal and aluminium sectors which have contracted slightly, down by around 20% by 2015 on the 2005 production. As with the Anglo American comparison, there appears to be little correlation between BHP Billiton's EV and production output. Even as production has been increasing from 2011 to 2015, EV continued to decline with declining prices. This again shows that production output did not drive EV for the period under consideration.

4.3.3 Rio Tinto's indexed production output

In comparison to BHP Billiton and Anglo American, Rio Tinto was only producing from five different commodity sectors as of 2005, as shown in Figure 4.6. This figure is based on input data from Appendix 7.11.

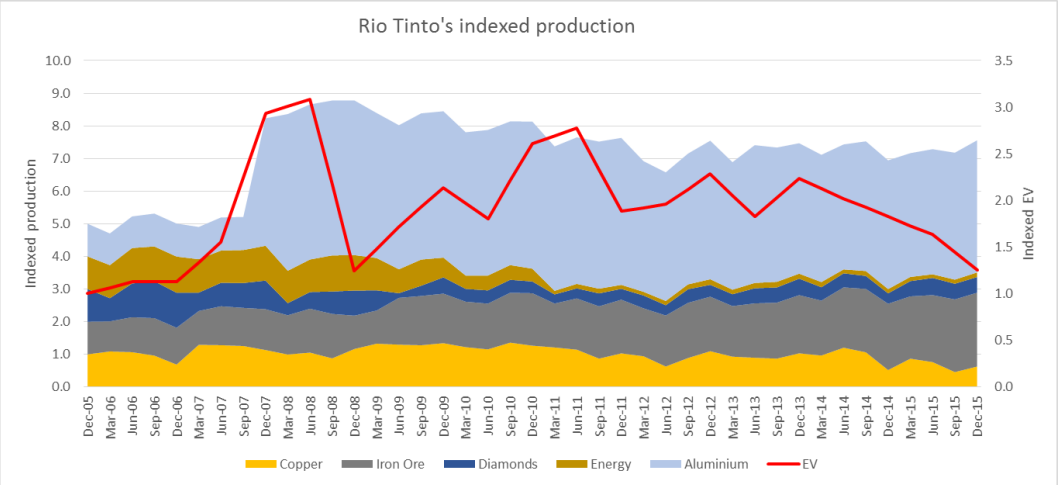


Figure 4.6 : Rio Tinto's indexed production and EV
Source : Rio Tinto (2006 – 2016a)

Rio Tinto's copper output has remained relatively flat over the period, contracting slightly for the last five years of the period. The company's energy sector is represented by thermal coal output from both the USA and Australia. In 2005 approximately 85% of Rio Tinto's thermal coal output was from the USA. This

dropped by 50% at the end of 2009 with a 50% initial public offering of its US thermal coal operations which were operated by Cloud Peak Energy Inc (Rio Tinto, 2009). The following year, in 2010, the company fully divested from Cloud Peak Energy Inc (Rio Tinto, 2010) resulting in Australia being the only source of its thermal coal production. As such from Q1 2011 total thermal coal production for the company was 15% of the 2005 output, with production remaining relatively flat following this. Diamond production, like Anglo American's output, is linked closely to demand requirements thus reducing short term supply in line with demand. Rio Tinto experienced a steady increase in iron ore production from early 2009 to doubling its 2005 output by the end of 2015.

The biggest change in production for the company was the increase in aluminium production in 2007. This jump in aluminium output was as a result of Rio Tinto's acquisition of Alcan to become the world's biggest aluminium producer. As a result of this transaction its quarterly production output increased over four times and has remained fairly stable for the remainder of the 10 years analysed. EV jumped by almost 300% with the acquisition of Alcan and the increased aluminium production. However, it would appear that as soon as prices dropped in 2008, EV dropped as quickly, returning to close to the 2005 levels by the end of 2008. This would suggest that whilst the rapid increase in production as a result of an acquisition increased EV, declining commodity prices can have a similar negative effect on EV. As such, commodity prices are analysed in a later section.

4.3.4 CVRD-Vale's indexed production output

Figure 4.7 shows CVRD-Vale's indexed production output and EV. The input data used in this figure is shown in Appendix 7.12.

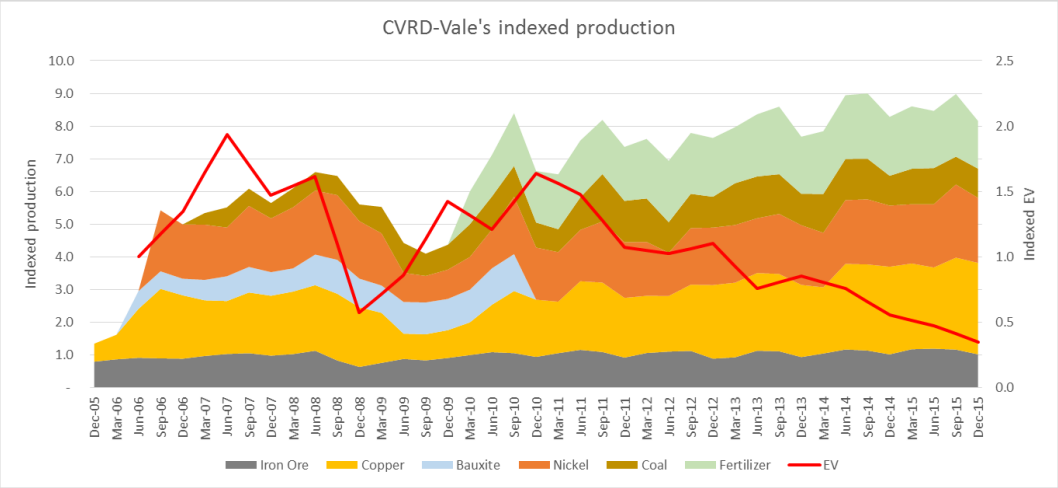


Figure 4.7 : CVRD-Vale's indexed production and EV
Source : Vale (2006 – 2016)

At the end of 2005 CVRD-Vale was primarily an iron ore producer with some copper assets. Following a strategic decision from 2006 to become a global diversified miner, between 2006 and 2010 the company added coal, nickel, fertilizer and bauxite segments to its business. Whilst production dropped in all of these sectors following the GFC, after this it increased until another drop at the end of 2010. Following this the company divested from bauxite however the other segments continued to grow from 2011 to 2015. Throughout the 10 year period, iron ore production remained relatively flat, with the diversification to other commodities adding onto this stable iron ore base. In comparing the production output and EV, it would appear that production output alone did not affect EV.

4.3.5 Correlation of production output to EV

The Pearson correlation coefficient of production output against EV is shown in Table 4.1 obtained from data in Appendix 7.9 to Appendix 7.12. These values confirm the inconsistent correlation that was observed in Figure 4.4 to Figure 4.7.

Table 4.1 : Pearson correlation coefficients of production output against EV

Anglo American	BHP Billiton	Rio Tinto	CVRD-Vale
-0.4	0.2	0.6	-0.4
Medium (-)	Low (+)	High (+)	Medium (-)

As can be seen from the Pearson correlation coefficients for production output against EV, there is weak correlation between production output and EV, except for Rio Tinto's anomaly associated with the acquisition of Alcan. This is because analysis of production provides no link to the economic factors associated with the extraction and sale of commodities. Increasing production in a commodity which has declining prices and high extractive costs can destroy value and is not represented in this metric. This lack of correlation can most clearly be seen in mid-2008, when there was little change in production for all companies, yet the company values dropped significantly for all companies. Rio Tinto was the only company with a high correlation possibly as a result of the increase in aluminium production as a result of the acquisition of Alcan which also resulted in a similar increase in EV. The only other correlation which can be observed is that changes to production appear to lag changes to EV. This would be expected as when a company is doing well, and the EV increases, the reaction is to increase production. Similarly when a company is not doing well, it reduces production in an attempt to cut costs. As such, analysis purely of production was determined not to be a driver of company value as it does not take into account the economic factors associated with this production. However, the production output of each sector was considered in the revenue calculation, as discussed in a later section of this study. Commodity price was also analysed to find if price influences EV.

4.4 Commodity price

As discussed previously in detail in Section 2.3.1, commodity prices fluctuated throughout the 10 year period. Appendix 7.13 to Appendix 7.15 show the indexed commodity price for the major commodities over the 10 years analysed. These graphs have been split into metal prices, bulk commodity prices and fertilizer prices, with the three segments showing slightly different trends over the period. From this it is clear that the commodities can be split into four main baskets, each displaying similar trends. These baskets are gold, bulks and energy, metals and

diamonds as shown in Figure 4.8. The bulks and energy basket was calculated by taking the average of the iron ore, hard coking coal, thermal coal and crude oil prices. The metals basket included copper, nickel, aluminium and platinum. The fertilizer price which is represented by the phosphate rock price is not shown on the graphs as it is not a key commodity and is a small contributor to CVRD-Vale's revenue. All prices were indexed back to the average price for the 2005 calendar year.

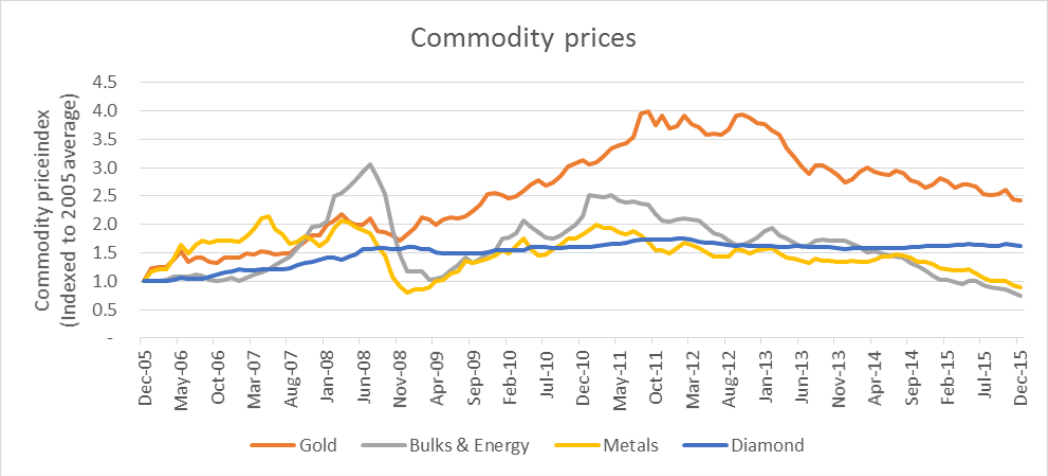


Figure 4.8 : Indexed baskets of commodity prices
Source : World Bank (2016)

From Figure 4.8 it is clear that the bulks and energy sector experienced the biggest rise in pricing from 2006 to 2008 but, were similarly the hardest hit in 2008 due to the GFC. This sector also suffered the biggest decline in price from 2010 to 2015. The metals sector, which includes platinum, was similar to gold in doubling its price from 2006 to 2008. However, when gold only dropped by around 20% with the onset of the GFC, metal prices halved. The post GFC recovery of all the sectors has been similar, however it is clear that those companies exposed to gold mining have fared better than the others. Similarly those exposed to bulks and energy, particularly iron ore and coal, should have had better earnings up until 2012 though they have been the hardest hit with declining prices from 2012 to 2015.

Of the companies analysed, only Anglo American and BHP Billiton had some exposure to gold. Anglo American sold out of the gold sector in 2007 and BHP Billiton's gold is an offtake product from its Olympic Dam operation. As such these four companies were not able to capitalise on the rising gold price post the GFC. Diamonds made a very small contribution to Anglo American's and Rio Tinto's revenue streams so does not have a big influence on the two companies' total revenue. Thus for most companies their revenue stream is primarily dependent on different exposure and production in the bulks and energy sector and metals segment, with this to be discussed for each company in the next section.

4.5 Commodity price and production output mix

Revenue was analysed using a combination of production output and commodity prices for each quarter. In essence this represents the changes in revenue generated by the commodities portion of each of the companies. The results were plotted on a stacked area graph, however instead of showing an indexed output on the primary axis, a percentage contribution to revenue for each commodity segment was used. The December 2005 data is the reported revenue contribution for each of the segments for the FY2005, with changes to production and commodity price varying the revenue for each segment. The graphs for the four companies are shown in Figure 4.9 to Figure 4.12 drawn from data in Appendix 7.16 to Appendix 7.19. As a check of the accuracy of the calculations, for Anglo American the actual reported revenue for 2015 was 70% of the 2005 level whilst the calculated value was 63%. This difference is because the estimated revenue uses a single commodity price and commodity production per segment, when in reality a segment may be made up of a number of different commodities. However, for the purpose of this comparison, the estimated revenue calculation is a good representation of the total revenue contribution of each commodity.

4.5.1 Anglo American's revenue

Figure 4.9 shows Anglo American's estimated revenue which was drawn using input data in Appendix 7.16. This has been calculated by multiplying the indexed commodity price by the indexed production output for each sector.

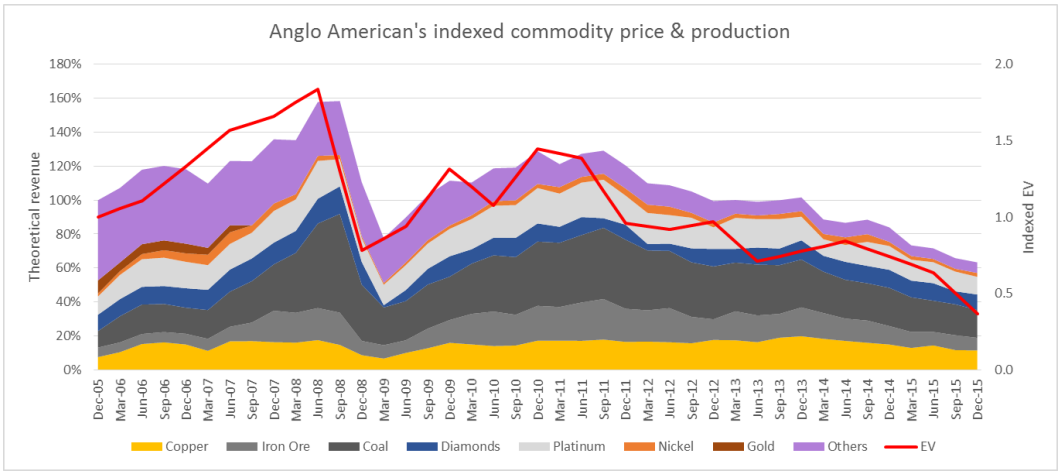


Figure 4.9 : Anglo American's estimated revenue and EV
Source : Anglo American (2006 – 2016)

As shown in Figure 4.9, in 2005 almost 50% of Anglo American's revenue was made up of non-mining based business. This included its steel businesses Scaw Metals and Samancor group, the sugar producer Tongaat-Hulett and a paper and packaging group Mondi. This lower reliance on mineral commodities from 2005 to 2008 when prices were booming could have been one of the reasons why Anglo American underperformed compared to the other companies (as indicated in Section 4.2) as it was not able to capitalise on booming commodity prices. The revenue contribution of this "others" group declined from 2005 to contribute around 10% of revenue as of 2015 as the company returned its focus on commodities. This included the disposal of the Mondi group in 2007 as discussed in Section 1.7.1.

The increased revenue from higher coal prices from 2005 to mid-2008 can be seen as a big contributor to Anglo American's revenue. An increase in coal and iron ore production over the 10 year period, as shown previously in Figure 4.4, has been

largely offset by declining prices in these sectors from mid-2011 to 2015. From 2010 to 2013 approximately 40% of its revenue was from iron ore and coal. This sector has had the biggest decline in prices from 2010 to 2015 meaning that Anglo American's revenue has been dropping, resulting in declining EV over this period. Unfortunately, as the company has started to increase iron ore output from late 2014 (as shown in Figure 4.4) with the commissioning of the Minas Rio project, this has been offset by faster declining prices meaning revenue from the sector continued to contract.

Revenue from copper, platinum and nickel has remained relatively flat between 2006 and 2015 except for a slight decline in 2008 during the GFC. However in total these two sectors contributed less than 20% of revenue for most of the 10 year period. Whilst Figure 4.4 shows nickel production growing from 2012 – 2015, it is such a small contributor to revenue that this had little influence on the total company's EV.

In comparing the estimated revenue to the EV, there appears to be a very good correlation between the two. The Pearson correlation, calculated between total revenue and EV, is very high at 0.9 as discussed later in this report. Apart from a slight drop in EV in late 2009/early 2010, which could be as a result of post GFC sentiment, in general the EV tracks very closely to estimated revenue. This would suggest that revenue is a key driver of EV for Anglo American, and could explain some of the trends in terms of the company's performance. For example, the lower increase in EV from 2006 to 2008 compared to the companies was primarily as a result of the company's higher exposure to non-commodity businesses. Then its slower recovery from 2008 to 2010 was due to the flat production in its iron ore and coal business, when prices were booming within these sectors. Finally, the faster decline from 2010 to 2015 is a consequence of its exposure to coal and iron ore, both of which have been the worst price performers over this period.

4.5.2 BHP Billiton's revenue

BHP Billiton is one of the two companies which increased its EV by approximately 15% from 2006 to 2015. It was the best performer of the four companies during the GFC commodity price crash, and together with Rio Tinto has significantly outperformed the other two companies from mid-2011 to 2015 as shown in Figure 4.1. Its revenue mix is shown in Figure 4.10 drawn from data in Appendix 7.17.

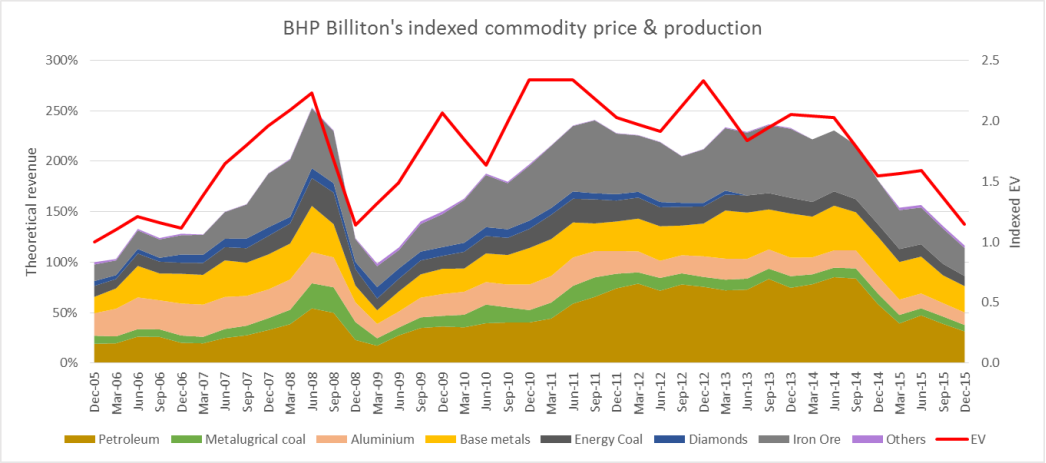


Figure 4.10 : BHP Billiton's estimated revenue and EV
Source : BHP Billiton (2005 – 2015) & South 32 (2105)

As of the end of 2005 the company was fairly well diversified, with approximately 20% of its revenue each from petroleum, aluminium, base metals and iron ore. These sectors grew primarily on higher commodity prices, though iron ore production was up by 20% in mid-2008 compared to 2005 (Figure 4.5) meaning it became a bigger contributor to revenue. It appears that BHP Billiton was the company least affected by the GFC due to a steady output of iron ore and petroleum which remained at above the 2005 output during the course of 2008. Then following the GFC, the company started to increase iron ore and petroleum production (Figure 4.5) with these two sectors growing to contribute over half of the company's revenue by 2011. It is likely that the strong recovery in EV from 2008 to 2011 can be attributed to this exposure and the increased production in these sectors. Copper also slightly grew to contribute around 20% of BHP Billiton's revenue from 2013. The consistent revenue from aluminium and base metals,

which have been less affected by declining prices from 2011, have resulted in a lower decline in EV than Anglo American and Rio Tinto which have a bigger exposure to iron ore.

In comparing BHP Billiton's EV to total theoretical revenue, like Anglo American it is clear that there is a close correlation between the two. As with Anglo American there appears to be a drop in EV in late 2009, and a similar drop in late 2012, both possibly as a result of pricing speculation. However, in general the trend appears to be close as is confirmed by the Pearson correlation which is high at 0.8.

4.5.3 Rio Tinto's revenue

Rio Tinto was by far the best performer from 2005 to 2008 as shown previously in Figure 4.1. It would appear this success can primarily be attributed to the company's iron ore, copper and aluminium divisions as shown in Figure 4.11 drawn using data from Appendix 7.18.

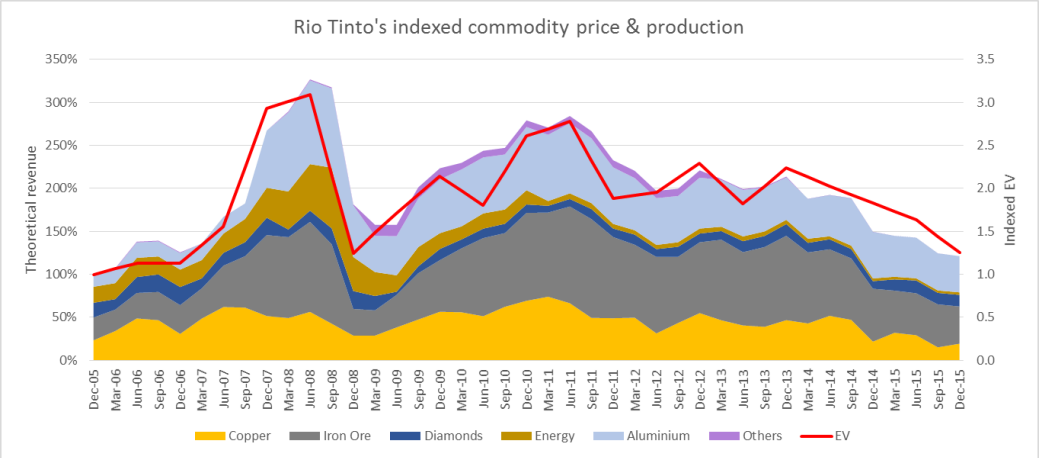


Figure 4.11 : Rio Tinto's estimated revenue and EV
Source : Rio Tinto (2006 – 2016a)

Rising iron ore prices from 2005 to 2008 resulted in the iron ore segment revenue increasing almost fourfold over the same period. Similarly, the acquisition of Alcan in 2007 resulted in aluminium production increasing almost fivefold, and the aluminium sector contributing close to one-third of revenue in mid-2008. Energy revenue, comprising Rio Tinto's thermal coal business, also grew in this period,

purely as a result of rising prices. As such, by mid-2008, total revenue had increased to over three times the 2005 level, with EV tracking closely with similar gains. However, this exposure to iron ore and coal resulted in the company being affected badly by the drop in bulk prices during the 2008 onset of the GFC. It was only its copper business revenue which remained relatively stable, with copper the least affected by declining prices. This segment was particularly important from 2011 to 2015 reducing some of the heavy losses from iron ore over the period.

With the recovery of all commodity prices post the GFC, Rio Tinto continued to increase iron ore production and was able to capitalise on iron ore being the best recovering commodity from the start of 2009 to the end of 2013. As such revenue from this sector increased almost threefold during 2009 remained at these levels until the end of 2013. However, has been steadily declining from the end of 2013 to 2015. For the same recovery period (2009 to 2013), aluminium's recovery was much slower than any of the other commodities.

As with the previous two companies, Rio Tinto's EV tracks very closely with its theoretical revenue. The extraordinary jump in revenue as a result of the Alcan acquisition resulted in a similar increase in EV. The Pearson correlation between the two is high at 0.9 confirming the direct relationship between EV and revenue. As with the others, price sentiment caused a drop in EV in late 2009 and 2012 against stable revenues for these periods. Revenue could also describe Rio Tinto's success prior to the GFC which can be attributed to increased iron ore output and the acquisition of Alcan. These two sectors, as well as a stable revenue stream from copper, have ensured the company's success following the GFC to 2015.

4.5.4 CVRD-Vale's revenue

Figure 4.12 shows CVRD-Vale's EV and revenue results drawn from data in Appendix 7.19. Unlike the other companies' production output and price data, which was indexed back to 100% in 2005, all CVRD-Vale data was indexed to 100%

in June 2010. This was because this was the first period where the company produced from all commodity sectors. EV is also only shown from mid-2006 due to a share split in early 2006.

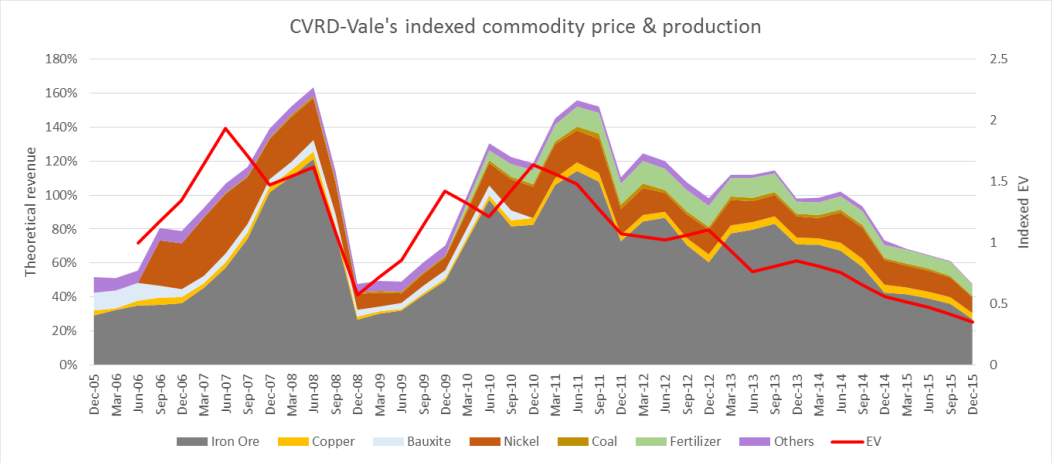


Figure 4.12 : CVRD-Vale's estimated revenue and EV
Source : Vale (2006 – 2016)

CVRD-Vale's primary commodity has traditionally been iron ore which contributed almost three-quarters of its revenue in 2005. In addition to this, in 2005 a 10% contribution was from its logistic business and aluminium and less than 5% from base metals and copper. A jump in nickel production, along with price growth from iron ore, resulted in revenue doubling from 2005 to mid-2008. However, it appears price expectations around iron ore resulted in a drop in EV in mid-2007 prior to the onset of the GFC.

It was CVRD-Vale's exposure to iron ore which caused total revenue, and as such company value, to drop considerably in 2008, but similarly recovered to pre-GFC levels in the following years. Increased production of coal, copper and fertilizer from 2010, as shown in Figure 4.7, contributed the least to earnings, primarily due to declining prices in these commodities over the same period. As such, where iron ore ensured recovery in 2009, this same sector was the worst performer in terms of price from 2013 to 2015 which meant that CVRD-Vale was the worst performer in terms of EV over the same period.

Thus the EV of CVRD-Vale can be predominately matched to the price cycles of iron ore. As such revenue has tracked EV with a high correlation of 0.7. Other than the unexplained drop in mid-2007, and the similar drops to the other companies in late 2009, changes to EV appear to be as a result of changes to revenue. Good growth in 2006 to 2008 was brought to an abrupt halt in 2008 by the GFC, followed by better than average recovery of prices post-GFC which ensured the rapid recovery of EV. Poor performance in this sector from 2013 to 2015 resulted in EV contracting to values below the 2006 level as of the end of 2015.

4.5.5 Correlation of revenue to EV

As discussed for each company in Section 4.5, the Pearson correlation coefficient of revenue against EV is shown in Table 4.2 obtained from data in Appendix 7.16 to Appendix 7.19. These values are all above 0.5 suggesting that there is a very strong correlation between revenue and EV.

Table 4.2 : Pearson correlation coefficients of revenue against EV

Anglo American	BHP Billiton	Rio Tinto	CVRD-Vale
0.9	0.8	0.9	0.7
High (+)	High (+)	High (+)	High (+)

In addition to the high correlation coefficient, graphically the correlation between company value and revenue can be clearly seen in Figure 4.9 to Figure 4.12. The total revenue tracks the EV for all the companies. As such, from both the Pearson correlation coefficient and graphical analysis of the commodity price and production mix compared to EV, it was determined that revenue is a strong driver of company value. It was therefore classified as a key value driver of company value. Since revenue is determined by both commodity price and production, companies must ensure that they are increasing production on commodities with

increasing prices. In many cases this may occur by luck, with prediction of key commodities for price growth a separate topic of discussion altogether.

4.6 Valuation multiples

Two different valuation multiples included in the analysis are EBITDA multiple and EBITDA margin. Figure 4.13 to Figure 4.16 show the valuation multiples against EV for the four companies. Appendix 7.20 to Appendix 7.27 present the input data for these graphs with Appendix 7.5 to Appendix 7.8 showing the source data used to calculate the valuation multiples and capital efficiency measures. Using a Pearson correlation coefficient analysis the relationships between changes to each metric and changes to EV were determined. It is important to note that since indexed values were used, this correlation is on changes to each metric rather than the discrete value of each.

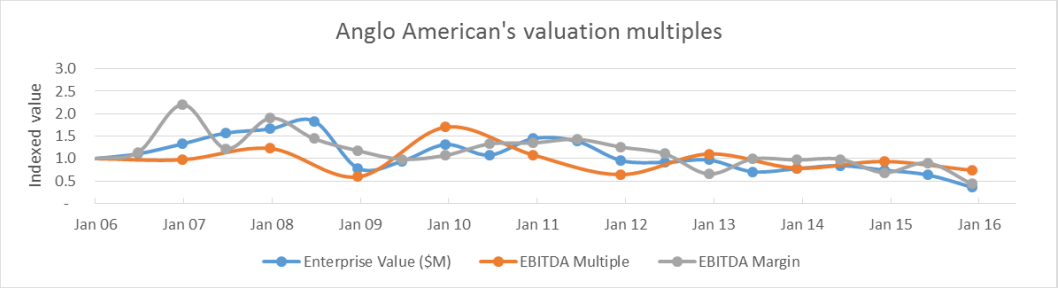


Figure 4.13 : Anglo American's valuation multiples compared to EV
Source : Anglo American (2006 – 2016)

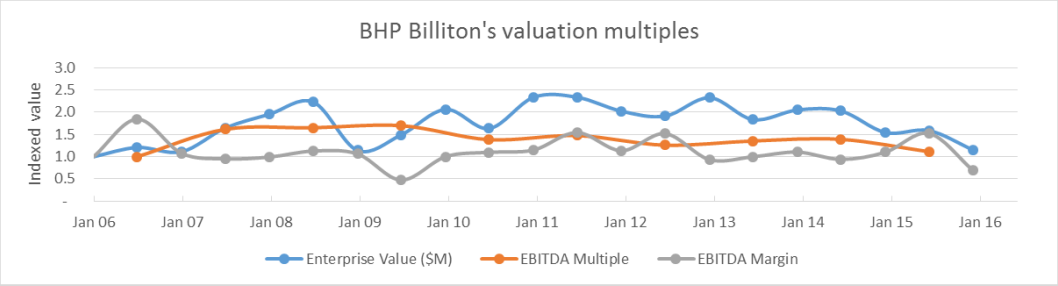


Figure 4.14 : BHP Billiton's valuation multiples compared to EV
Source : BHP Billiton (2005 – 2015) & South 32 (2105)

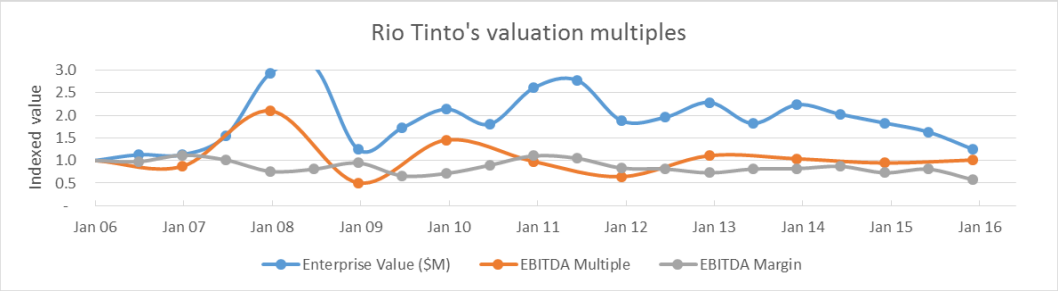


Figure 4.15 : Rio Tinto's valuation multiples compared to EV
Source : Rio Tinto (2006 – 2016a)

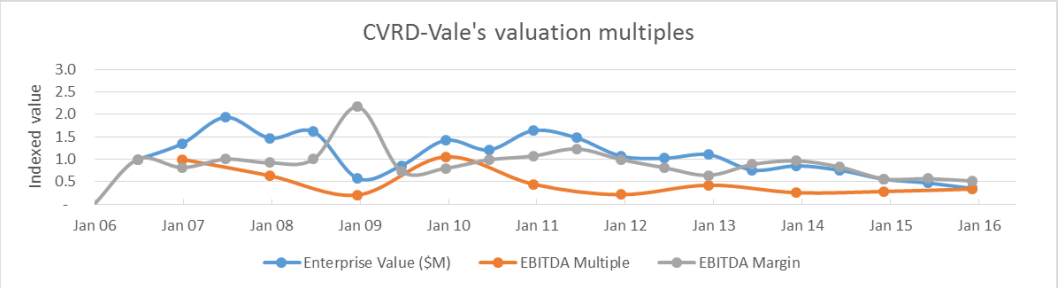


Figure 4.16 : CVRD-Vale's valuation multiples compared to EV
Source : Vale (2006 – 2016)

As can be seen from Figure 4.13 to Figure 4.16 the EBITDA multiple tracks EV relatively closely for all the companies except BHP Billiton, where the EBITDA multiple has remained relatively flat. In contrast there is little correlation with EBITDA margin, with little movement in this metric over the 10 years for all companies. To confirm these observations the Pearson coefficient was calculated to determine the correlation between the valuation multiples and EV.

4.6.1 Analysis of EBITDA multiple

Table 4.3 shows the Pearson correlation coefficient for EBITDA multiples for the four companies. These are based on the data included in Figure 4.13 to Figure 4.16.

Table 4.3 : Pearson correlation coefficients of EBITDA multiple against EV

Anglo American	BHP Billiton	Rio Tinto	CVRD-Vale
0.6	0.4	0.6	0.6
High (+)	Medium (+)	High (+)	High (+)

From these coefficient values, it can be seen that there is a high correlation between changes to EBITDA multiple and EV for all companies except BHP Billiton, which was slightly below 0.5. This is in line with the observations from the graphs where EBITDA multiple tracks EV closely. An alternate analysis, as shown in Figure 4.17, was to compare the EBITDA multiples of each of the companies, rather than the indexed values.

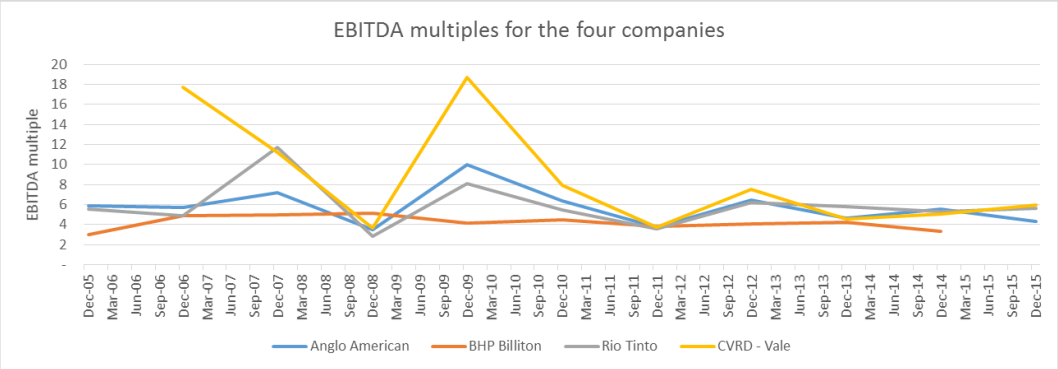


Figure 4.17 : EBITDA multiples for the four mining companies
Sources : Anglo American (2006 – 2016), BHP Billiton (2005 – 2015), South 32 (2015), Rio Tinto (2006 – 2016a) & Vale (2006 – 2016)

Other than CVRD-Vale being quite volatile during the GFC when earnings were also unstable, on average all companies are within the window of around 6.0 EBITDA multiple. The EBITDA multiple for BHP Billiton, the lowest for most of the period, has remained relatively stable around 4 for the entire period. Anglo American and Rio Tinto have tracked fairly closely throughout the period, indicating no major difference between EV to earnings between the two. This would suggest that the levels of EBITDA multiple are not a key value driver of company value.

In summary, based on the Pearson coefficient between EBITDA multiple and EV, there is a high correlation. As such this suggests that EBITDA multiple is a key driver of company value, however more so changes to EBITDA multiple rather than the actual value of such.

4.6.2 Analysis of EBITDA margin

Analysis of the previously shown Figure 4.13 to Figure 4.16 suggest that there is little correlation between EBITDA margin and EV. The Pearson correlation coefficients confirm this as shown in Table 4.4.

Table 4.4 : Pearson correlation coefficients of EBITDA margin against EV

Anglo American	BHP Billiton	Rio Tinto	CVRD-Vale
0.7	0.1	-0.1	0.1
High (+)	Low (+)	Low (-)	Low (+)

EBITDA margin, a measure of the portion of revenue which is earnings compared to costs, has a very low Pearson correlation coefficient against EV in all the companies except Anglo American. The reason for this high correlation for Anglo American could possibly related to the company's efforts to decrease their EBITDA margin from 2011 when at the same time EV was declining. For Rio Tinto, there is a negative low correlation between EV and EBITDA margin. Because of this variability, in terms of correlation to EV it appears that EBITDA margin is not a value driver. Similarly in comparing the EBITDA margin between companies as shown in Figure 4.18, there appears to be a weak correlation between the companies which performed well, and those which did not do as well.

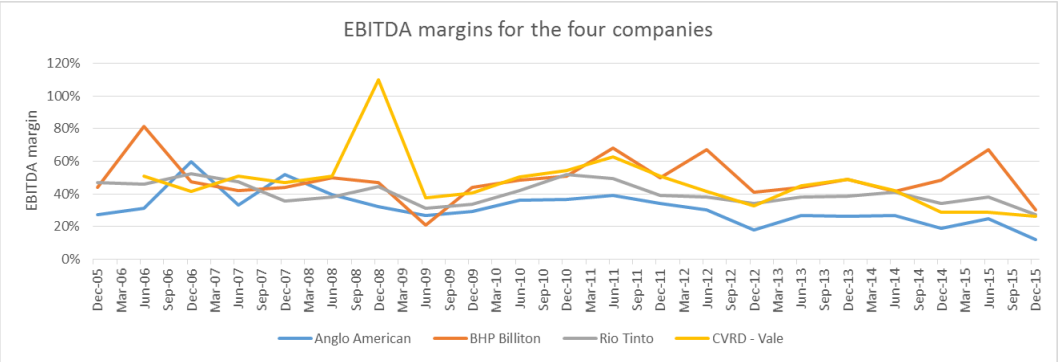


Figure 4.18 : EBITDA margins for the four mining companies
Sources : Anglo American (2006 – 2016), BHP Billiton (2005 – 2015), South 32 (2015), Rio Tinto (2006 – 2016a) & Vale (2006 – 2016)

One comment which is relevant is that Anglo American, which was the worst performing company over the 10 year period, has the lowest EBITDA margin for most of the period. This could suggest that high costs does have an effect on company value. However, this is not confirmed by the CVRD-Vale data, particularly for the period 2009 – 2015 which had a higher EBITDA margin than Rio Tinto but lost more company value. Over that same period, CVRD-Vale appears to have the fastest declining EBITDA margin which would suggest that it was struggling to control costs. Thus, whilst EBITDA margin is an important metric for ensuring costs are kept to a reasonable level, this does not appear to be a key driver of company value.

4.7 Capital efficiency ratios

The three potential capital efficiency value drivers analysed were gearing ratio, net debt to EBITDA and ROCE. As with the valuation multiples, the indexed values were compared to EV for each company to determine if correlation exists between the indexed values and EV. Then the actual ratios were compared between companies to identify any trends between the four companies. The indexed capital efficiency measures for each company are shown in Figure 4.19 to Figure 4.22.

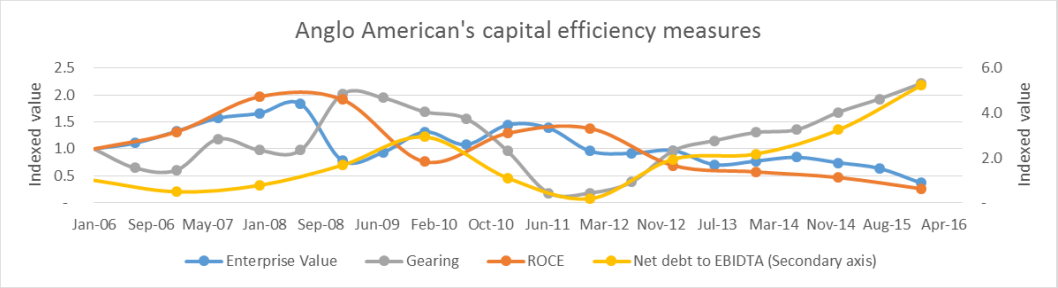


Figure 4.19 : Anglo American's capital efficiency measures
Source : Anglo American (2006 – 2016)

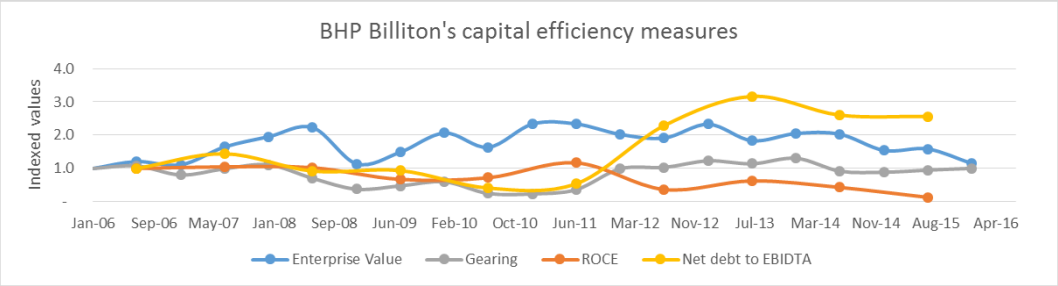


Figure 4.20 : BHP Billiton's capital efficiency measures
Source : BHP Billiton (2005 – 2015) & South 32 (2105)

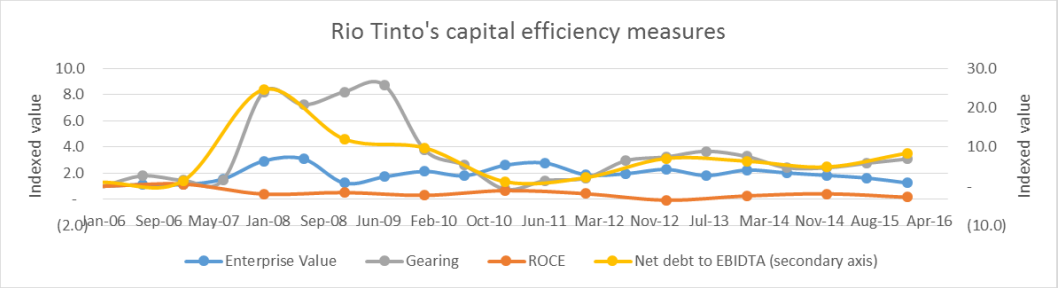


Figure 4.21 : Rio Tinto's capital efficiency measures
Source : Rio Tinto (2006 – 2016a)

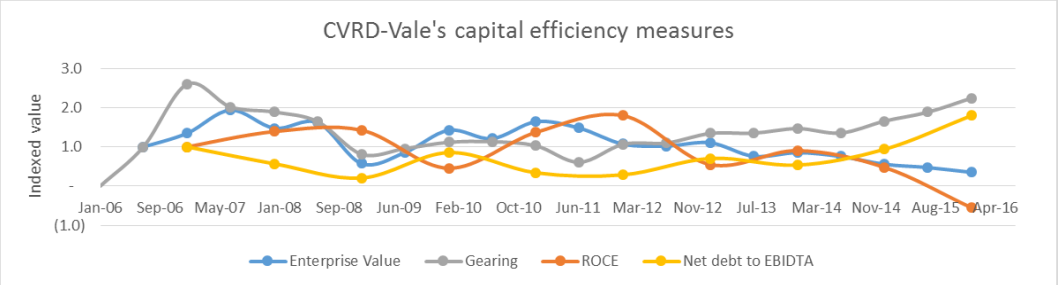


Figure 4.22 : CVRD-Vale's capital efficiency measures
Source : Vale (2006 – 2016)

As with the valuation multiples it is difficult to see any clear correlation between the capital efficiency measures and EV for each of the companies. As such the Pearson correlation coefficient was calculated for each capital efficiency measure.

4.7.1 Analysis of gearing ratio

Table 4.5 shows the Pearson correlation coefficients for gearing ratio against EV for each of the companies. What is notable is that for two of the companies, Anglo American and BHP Billiton the correlation coefficients are negative, and for the other two the correlation coefficients are positive. This means that for those

companies with a positive correlation, as gearing ratio increases EV also increases, whereas when the correlation is negative the opposite occurs.

Table 4.5 : Pearson correlation coefficients of gearing ratio against EV

Anglo American	BHP Billiton	Rio Tinto	CVRD-Vale
-0.5	-0.1	0.3	0.2
Medium (-)	Low (-)	Low (+)	Low

Since the correlation is low for three of the companies this would suggest that gearing ratio is not a driver of EV. Similarly, for Anglo American whilst the correlation is medium, it is a negative correlation. This can be observed in Figure 4.19 that when the gearing ratio is high, EV is low and vice versa. However, this is in contradiction to Rio Tinto which has a low/medium positive correlation with EV, though this is much more difficult to observe in Figure 4.21. As an additional comparison, Figure 4.23 shows a comparison of gearing ratios between the four companies.

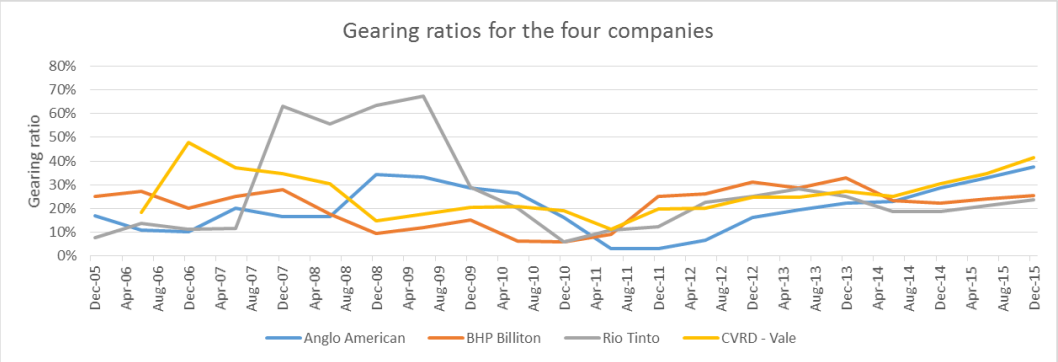


Figure 4.23 : Gearing ratios for the four mining companies
Sources : Anglo American (2006 – 2016), BHP Billiton (2005 – 2015), South 32 (2015), Rio Tinto (2006 – 2016a) & Vale (2006 – 2016)

In the first five years of Figure 4.23 there was a large spread between each of the companies and only from 2011 where the ratios were more closely aligned. Rio Tinto had an exceptionally high debt level from 2007 to 2009, primarily as a result of the acquisition of Alcan. This acquisition boosted Rio Tinto's aluminium production and EV to make it the best performer among the four companies from 2006 to the GFC in mid-2008. What is surprising is that the high levels of debt

associated with this acquisition did not appear to affect the company's value compared to the other companies. As such it would appear that in the boom and recovery period from 2006 to 2010, gearing had little effect on EV. This is likely because companies and investors were both chasing growth at any cost rather than considering debt levels.

A trend is apparent from the period of declining prices from 2011. Whilst Anglo American had the lowest gearing ratio as of 2011, it started to borrow with its net debt rising from $USb1.4 at the end of 2011 to a peak of $USb13.5 in June 2015 as shown in Appendix 7.5. This jump in debt was primarily associated with the acquisition of the Minas Rio Iron Ore project. However, what is different to Rio Tinto's 2007 jump in debt is that little was added to EV with this increased debt. CVRD-Vale was similar, with its gearing ratio increasing from 10% in June 2011 to over 40% at the end of 2015. This is in comparison to BHP Billiton and Rio Tinto, which both had better EV performances over this period and maintained their gearing ratios at less than 25%.

Both BHP Billiton and Rio Tinto make mention of gearing in their 2015 annual reports. BHP Billiton in its policy on debt and liquidity management indicated that gearing should be a maximum of 40% (BHP Billiton, 2015). Rio Tinto was more conservative suggesting that the gearing ratio should be kept between 20% and 30% in order to maintain a robust balance sheet (Rio Tinto, 2015). Neither Anglo American nor CVRD-Vale made any mention on a focus or target for gearing, which could explain why this ratio has been increasing for these companies.

Thus whilst analysis of EV and gearing ratio over the 10 year period suggests that there is low a correlation, comparison of short periods indicate some correlation. In the period of declining prices from mid-2011 to end of 2015, those companies with faster increasing gearing ratios had more rapidly declining EV. In fact, when the Pearson correlation coefficient between EV and gearing ratio is calculated over the period from 2011 to 2015, the correlation was high and negative for all

companies. This would suggest that gearing ratio is only a value driver in times of declining commodity prices. In many cases this is when asset write downs are common and as such investors and companies are concerned with levels of debt, which as such can affect share price.

4.7.2 Analysis of net debt to EBITDA ratio

Net debt to EBITDA ratio is a similar measure to gearing ratio, in that it is a measure of how much debt the company has. As such, as can be seen in Figure 4.19 to Figure 4.22 the net debt to EBITDA and gearing ratios track relatively closely. Table 4.6 shows the Pearson correlation coefficients for net debt to EBITDA ratio against EV.

Table 4.6 : Pearson correlation coefficients for net debt to EBITDA ratio against EV

Anglo American	BHP Billiton	Rio Tinto	CVRD-Vale
-0.7	0.0	0.5	-0.4
High (-)	Low	Medium (+)	Medium (-)

For all four companies there does not appear to be a consistent correlation between net debt to EBITDA and EV. BHP Billiton had no correlation, meaning the values are completely random to each other, whilst Anglo American and CVRD-Vale had a negative correlation and Rio Tinto a positive one. This suggests that based on the Pearson correlation coefficient analysis over the 10 year period, net debt to EBITDA is not a driver of EV. Analysis of the values between companies, as per Figure 4.24 confirm similar observations to those from gearing ratio analysis.

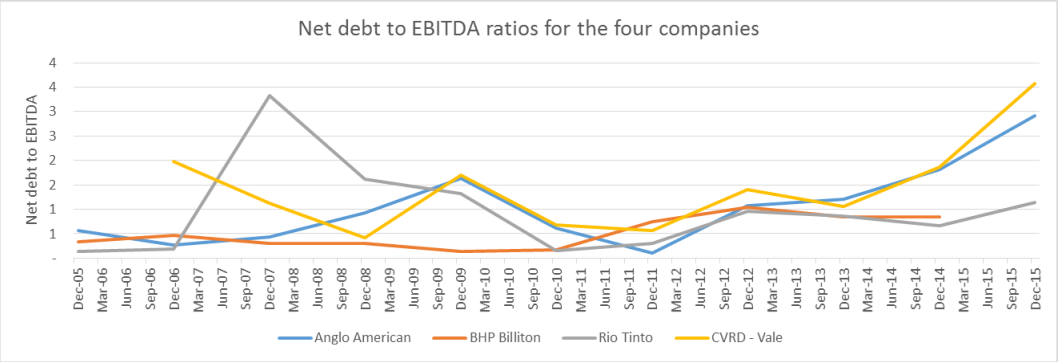


Figure 4.24 : Net debt to EBITDA ratio for the four mining companies
Sources : Anglo American (2006 – 2016), BHP Billiton (2005 – 2015), South 32 (2015), Rio Tinto (2006 – 2016a) & Vale (2006 – 2016)

As with the gearing ratio, the most noticeable trend is the sharply increasing net debt to EBITDA ratio for Anglo American and CVRD-Vale from 2011 to 2015. Whilst all companies have experienced an increase in net debt to EBITDA ratio as a result of reduced earnings from the end of 2010, Anglo American has made the situation worse by its rapid increase in debt. As with the gearing ratio, Rio Tinto's debt levels jumped with the acquisition of Alcan, however it succeeded in getting this under control and to manageable levels over the next three years post the acquisition. Both BHP Billiton and Rio Tinto have managed to maintain this ratio between one and two from 2010 to 2015, giving the companies added flexibility during times of decreasing earnings.

According to Price Waterhouse Coopers (2016) net debt to EBITDA ratios above four should cause alarm, which none of these companies achieved. However, the Price Waterhouse Coopers (2106) also indicated that the average net debt to EBITDA ratio of the top 40 mining companies was 1.52 in 2014 and 2.46 in 2015. Thus, the two companies, BHP Billiton and Rio Tinto, which have performed relatively well over the 2010 – 2015 period, have net debt to EBITDA ratios less than the average, and the other two companies which have performed poor have ratios above this average.

To confirm the observation of correlation when prices were declining, the Pearson correlation between net debt to EBITDA and EV for the period from end-2010 to

end-2015 was calculated. All companies had a high negative correlation with Anglo American, BHP Billiton and CVRD-Vale having a correlation coefficient of -0.8 which suggests a very high correlation. This indicates that as with gearing ratio, net debt to EBITDA ratio is particularly important in times of declining prices and revenues. More specifically, in times of declining prices, the issue of net debt must be kept to a manageable level depending on company size and industry outlook, measured against value and company earnings.

4.7.3 Analysis of ROCE

The final capital efficiency metric, is ROCE which is a measure of how well a company uses capital to generate returns. Analysing Figure 4.21 it appears that for Rio Tinto, ROCE was relatively flat and thus had little influence on EV. However, from the Pearson correlation coefficient, as shown in Table 4.7 Rio Tinto has a medium negative correlation between ROCE and EV.

Table 4.7 : Pearson correlation coefficients of ROCE against EV

Anglo American	BHP Billiton	Rio Tinto	CVRD-Vale
0.3	0.2	-0.5	0.5
Low (+)	Low (+)	Medium (-)	Medium (+)

Both Rio Tinto and CVRD-Vale had a medium correlation, but one was negative and the other positive. Both Anglo American and BHP Billiton had low positive correlation coefficients. This range of values suggests that there is little correlation between ROCE and EV. This is confirmed by analysing the ratios between companies, as shown in Figure 4.25.

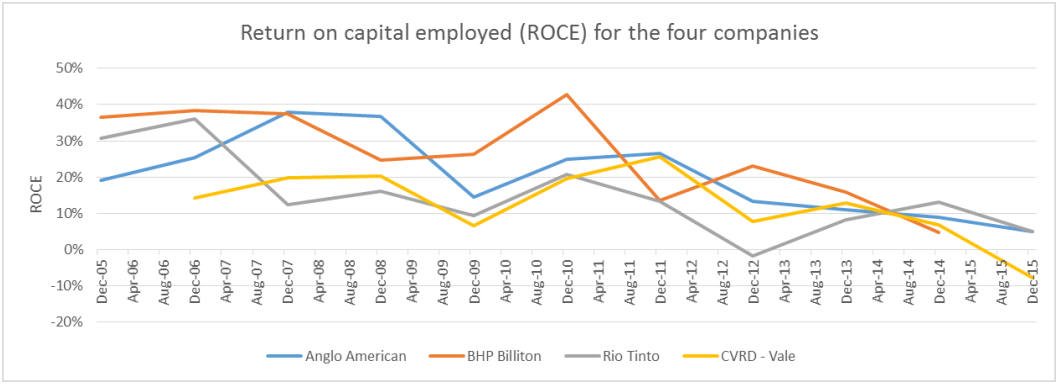


Figure 4.25 : Return on capital employed for the four mining companies
Sources : Anglo American (2006 – 2016), BHP Billiton (2005 – 2015), South 32 (2015), Rio Tinto (2006 – 2016a) & Vale (2006 – 2016)

For all companies, the trend is generally downwards, as declining prices make it more difficult to get the higher returns from the same capital. Anglo American is particularly interesting to analyse since ROCE is the primary return measure used by the company. In 2013, with the appointment of its new CEO Mark Cuttifani, the company reported that it was focusing on ROCE, stating that "during the downturn we have seen the mining industry's ROCE plummet from around 24% to about 10%" (Anglo American, 2014, p9). At that time its ROCE was around 11% and the company committed to a target of a sustainable minimum ROCE of 15% by 2016. The company was so committed to this that the CEO's bonus was linked to achieving this 15%. ROCE then decreased even further to 9% in 2014 and then 5% in 2015 (Anglo American, 2016b), suggesting that this measure was not being achieved. None of the other companies reported their ROCE or made reference to ROCE in their annual reports, suggesting that it is not an important metric for them.

Whilst Anglo American is very focused on ROCE, the general spread and trends shown in Figure 4.25 suggest that ROCE is not a key value driver of company value. Where Anglo American had a significantly higher ROCE than Rio Tinto and CVRD-Vale in 2008 and 2009, the company was the worst performer in terms of growing company value. Similarly Rio Tinto had a number of years of very low ROCE yet it has been one of the top performers of the four companies. As such it can be

confirmed and concluded that based on this analysis and the Pearson correlation coefficients, ROCE is not a key driver of company value.

4.8 Chapter summary

Analysis of the different metrics, using both a visual comparison of the relationship between the metric and EV and by calculating the Pearson correlation coefficient between each metric and EV, determined the key drivers of company value. Analysis of production output on its own, not considering any of the economic elements (especially price), indicated that there was no direct relationship between production output and EV. Instead, this metric is only a value driver when related with commodity price to derive revenue for the sector. Revenue appeared to have the greatest influence on EV, and as such is the most important key driver of EV and thus company value.

From analysis of the four companies it was found that there is a correlation between EBITDA multiple and EV from both the observed trends between EV and EBITDA multiple and the Pearson correlation coefficient for the four companies. For the two debt based ratios, gearing and net debt to EBITDA, whilst both had inconsistent correlations over the full 10 year period, they had high correlation to EV for the period of declining prices from the end of 2010 to 2015. This would suggest that both gearing and net debt to EBITDA ratios only influence company value in times of declining commodity prices. EBITDA margin and ROCE were found to have no correlation to EV, and as such are not key drivers of company value.

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Chapter overview

This final chapter provides an overview of the findings from the research study. First, each of the potential value drivers analysed are reviewed and the key drivers of company value identified. Then the observations of trends in company performance are discussed and summarised. Finally, a number of recommendations are provided for additional work given the outcomes of this research study.

5.2 Findings

Eight different potential value drivers were analysed against EV to determine which were key drivers of company value. These eight different potential drivers are production output, commodity price, revenue (calculated based on the production and commodity price), EBITDA multiple, EBITDA margin, gearing ratio, net debt to EBITDA and ROCE. A number of findings were observed when comparing each of these potential drivers with EV as discussed in the following sub-sections.

5.2.1 Production output

Production output was found not to be a driver of company value. This is because this metric does not take into account any economic factors, in particular commodity price. For example, increasing production in a commodity which has declining prices or high extractive costs can destroy rather than increase EV. This was observed from 2011 to 2015, when whilst most of the four companies increased total production output, EV decreased as a result of the declining commodity prices. This suggests that production output alone is not a key driver of company value.

5.2.2 Commodity prices

Analysis of commodity price trends over the ten year period was found not to be a driver of company value. This is because of the differing performance of the different commodities' prices over the period. Where diamonds prices have remained relatively flat over the period, bulk commodities and energy prices increased almost four fold from 2005 to mid-2008. As such any correlation between company value and commodity prices must consider the exposure the company has to each commodity. For non-diversified mining companies, which only have exposure to a single commodity, the commodity price would be a key value driver the price would directly influence revenue. However, for diversified multi-commodity companies a more suitable metric is to combine production output and commodity price to estimate revenue.

5.2.3 Revenue

Each company's total revenue was analysed by combining production output and commodity price for each quarter. This calculation represents an estimate of the revenue for the different companies as a result of production output and price variations. For all four companies this was found to have a very strong correlation with EV from both the visual analysis of the results and by calculating the Pearson correlation coefficient between the two. This suggests that the basket of commodities which a company produces is a major driver of company value. Companies must ensure that they are increasing production on commodities with increasing prices. Unfortunately given the difficulties in accurate forecasting of prices, and even if these are correct, the scarcity of mineral deposits and the long lead time to develop a mining operation make it difficult for a company to pick and choose the best performing commodities to invest in. However, some consideration should be given to the selection of value adding mineral commodities in order to drive revenue and consequently company value.

5.2.4 EBITDA multiple

EBITDA multiple, which is a measure of company value as a multiple of annual earnings, was found to have a high correlation to EV for all four companies. As such, it is considered a key driver of company value. As EBITDA and revenue are closely aligned, this would support the previous findings that revenue is a key driver. As such, companies must focus on increasing earnings. Major decreases to earnings will likely result in a similar drop in EV as the EBITDA multiple normalises this out.

5.2.5 EBITDA margin

EBITDA margin is a measure of the relationship between revenue and earnings and represents a company's ability to keep its costs under control. Surprisingly EBITDA margin was found not to have a correlation to EV for any of the companies except Anglo American. As such it was not considered a key driver of company value. Whilst there may not be a direct link Anglo American, which was the worst performing company over the 10 year period, had the lowest EBITDA margin indicating that cost control is an important consideration for company value.

5.2.6 Gearing ratio

The two metrics analysed which consider a company's debt was gearing ratio and net debt to EBITDA. Gearing ratio is a measure of debt to total company assets and provides an indication of the company's financial strength. A gearing ratio that is too high increases financial risk. Gearing ratio was not found to have a correlation with EV for the period from 2005 to 2011 when commodity prices were rising, then crashed with the onset of the GFC and subsequently recovered. However, from 2011 to 2015, a period which has seen commodity prices slowly declining, there is a high correlation between EV and gearing. This would suggest that gearing, and as such debt levels, are more important in times of declining commodity prices and revenue. This is because during these periods, declining

revenue raises concerns around a company's ability to make debt repayments, with these making up a growing portion of the company costs. During these times companies must consider and manage their levels of debt.

5.2.7 Net debt to EBITDA ratio

Net debt to EBITDA ratio measures the company's ability to pay back its debt from earnings. As with gearing ratio, a noticeable trend was an increasing gearing ratio and declining EV for Anglo American and CVRD-Vale from 2011 to 2015. However, like gearing ratio, there was no correlation between net debt to EBIDTA ratio from 2005 to 2011. Only from 2011 to 2015 when prices were declining was there a strong correlation between EV and net debt to EBITDA ratio. This confirms the conclusions from gearing ratio which means that debt is a key driver of company value in times of declining commodity prices.

5.2.8 ROCE

ROCE is a measure of a company's use of capital to generate revenue. Interestingly Anglo American consider this as an important metric that from 2014 they included ROCE in its CEO's performance measures. However, from analysis of the four companies there was found to be no correlation between EV and ROCE. In fact Rio Tinto had the lowest ROCE from end-2010 to 2015 yet was one of the better performing companies during that period. Whilst Anglo American considers ROCE to be an important metric, the data analysed in this study suggests otherwise. This highlights the importance of understanding which metrics are key value drivers and which have little correlation to company value.

5.2.9 Specific vale drivers over the 10 year period

The initial analysis of company value raised a number of key questions regarding the differing performance of the four companies. Each of these were considered in terms of the identified value drivers, to guide the determination of the metrics

which most influence company value. Rio Tinto's relative outperformance from 2005 – 2008 can be attributed to its acquisition of Alcan which increased the company's aluminium output almost fivefold and contributed to a doubling of revenue. Whilst net debt increased significantly over this period, affecting gearing ratio and net debt to EBITDA, this did not appear to have a negative effect on EV. This is possibly due to the high commodity prices and increased revenue that was generated during that period. As such this above par performance was primarily revenue driven.

Anglo American's underperformance in 2006 to 2008 is potentially due to its reduced exposure to mineral commodities over that period. In 2005 over 50% of its revenue was from non-mining business, much of which was not experiencing the price growth that the commodity sector was. This meant that Anglo American's revenue growth was not the same as for the other mining companies, and as such EV did not grow significantly. Similarly the company's poor recovery post-GFC can be attributed to a lack of capitalising on rising prices with flat iron ore and coal production outputs. As such this is also linked to revenue.

BHP Billiton seems to have fared the best during the GFC price drop by increasing iron ore and petroleum production output to minimise the effect on revenue. It also appears that the company's diversification strategy, ensuring a mix of revenues rather than a focus on a single commodity has kept the volatility of revenue to a minimum.

The poor performance of Anglo American and CVRD-Vale compared to BHP Billiton and Rio Tinto from 2011 to 2015, when commodity prices were steadily declining, appears to be as a result of rising debt within the two companies. This is reflected in changes to the gearing ratio and net debt to EBITDA ratios which were rapidly rising for both companies from 2011 to 2015. In contrast the better performing companies, BHP Billiton and Rio Tinto, maintained stable gearing ratios and net debt to EBITDA ratios during this same period.

5.3 Research limitations

This research was limited to an analysis of four major international diversified mining companies. As such the findings could be limited by the similar histories and operating environments for the four companies. Similarly the full effect of any mergers, demergers, acquisitions and sales were not able to be fully captured in the analysis. These could have influenced EV in areas other than the analysed metrics.

5.4 Recommendations for improved performance in mining companies

Mining companies must ensure that they understand the importance of value drivers when determining which metrics form part of their KPI's. These drivers must be those which management are able to influence and which have a high impact on company value. From this study of value drivers, mining companies should consider the following when selecting which metrics to focus on:

- Revenue was found to be the number one value driver. Since revenue is determined by both commodity price and production, companies must ensure that they are increasing production of those commodities with increasing prices;
- Whilst companies that focused on single commodity's experienced higher revenues when specific commodities were booming, in times of lower commodity prices revenue was similarly negatively affected. As such diversified multi-commodity companies experienced much more stable revenue, and thus EV, due to the variable performance of each commodity. It is therefore recommended that, as much as practical, major mining companies diversify across a range of commodities to maintain more stable revenue and thus company value;

- Earnings was also found to be an important driver for company value and as such companies must manage their EBITDA margin and EBITDA multiples;
- Debt related ratios appeared to only influence company value in times of declining prices and as such declining revenue. Thus, during these periods companies should consider and manage their debt levels in relation to earnings and EV; and
- ROCE was found to not have a high correlation with company value. Thus, whilst Anglo American has selected ROCE as a KPI for senior management, this study indicates that this metric does not have a high impact on EV. As such the company should review this decision and confirm how changes to ROCE impact company value.

5.5 Recommendations for future research work

On completion of the research study a number of additional queries arise leading to possible future research and these are:

- Whilst this study was focused on the period till the end of 2015, 2016 has been an interesting year for mining companies. As of mid-November 2016, all four companies' share prices, and as such EVs have increased significantly from the 2015 closing prices. BHP Billiton and Rio Tinto were up by approximately 50%, CVRD-Vale well over doubled in price and Anglo American was 390% higher. This would suggest that some changes in market conditions and as such the identified key drivers for company value should be confirmed for the 2016 period;
- Other value drivers could be considered, particularly non-financial metrics. This could include changes to company management; mergers, demergers, acquisitions and sales; capital write-downs and other company announcements; and

- The study could be expanded to include a broader range of mining companies. This could include juniors and less diversified companies to analyse if these same value drivers are relevant for the entire industry.

6 REFERENCES

Anglo American (2006) Annual Report 2005. INTERNET http://www.angloamerican.com/~/media/Files/A/Anglo-American-PLC-V2/investors/a-reports/2006rep/ar2005a/ar2005a.pdf Cited 10 July 2016.

Anglo American (2007) Annual Report 2006. INTERNET http://www.angloamerican.com/~/media/Files/A/Anglo-American-PLC-V2/investors/a-reports/2007rep/annual_report_2006.pdf Cited 10 July 2016.

Anglo American (2008) Annual Report 2007. INTERNET http://ar07.angloamerican.solutions.investis.com/ Cited 10 July 2016.

Anglo American (2009) Annual Report 2008, INTERNET http://www.angloamerican.com/~/media/Files/A/Anglo-American-PLC-V2/investors/a-reports/2009rep/ar2008.pdf Cited 10 July 2016.

Anglo American (2010) Annual Report 2009. INTERNET http://www.angloamerican.com/~/media/Files/A/Anglo-American-PLC-V2/investors/a-reports/2010rep/Anglo_American_2009_Annual_Report.pdf Cited 10 July 2016.

Anglo American (2011) Annual Report 2010. INTERNET http://www.angloamerican.com/~/media/Files/A/Anglo-American-PLC-V2/investors/a-reports/2011rep/angloamerican-annual-report-2010.pdf Cited 10 July 2016.

Anglo American (2012) Annual Report 2011, INTERNET http://www.angloamerican.com/~/media/Files/A/Anglo-American-PLC-V2/investors/reports/aa-annual-report-2011.pdf Cited 10 July 2016.

Anglo American (2013) Annual Report 2012. INTERNET http://www.angloamerican.com/~/media/Files/A/Anglo-American-PLC-V2/investors/reports/annual-report2012.pdf Cited 10 July 2016.

Anglo American (2014) Annual Report 2013. INTERNET http://www.angloamerican.com/~/media/Files/A/Anglo-American-PLC-V2/investors/reports/annual-report2013.pdf Cited 10 July 2016.

Anglo American (2015) Annual Report 2014. INTERNET http://www.angloamerican.com/~/media/Files/A/Anglo-American-PLC-V2/report-builder-2014/annual-report/aa-ar14-interactive-final.pdf Cited 10 July 2016.

Anglo American (2016a) History. INTERNET http://www.angloamerican.com/about-us/history Cited 10 September 2016.

Anglo American (2016b) Annual Report 2015. INTERNET http://www.angloamerican.com/~/media/Files/A/Anglo-American-PLC-V2/documents/aa-ar-15.pdf Cited 10 July 2016.

Baurens, S. (2010) Valuation of metals and mining companies. INTERNET http://ehrenworthsyme.com/casadeleon/Docs/ValuationofMining.pdf Cited 5 July 2016.

Baxter, R. (2009) The global economic crisis and its impact on South Africa and the country's mining industry. South Africa: Chamber of Mines.

Beattie, A. (2016) A beginners guide to mining stocks. INTERNET http://www.investopedia.com/articles/basics/12/beginners-guide-mining-stocks.asp Cited 5 July 2016.

BHP Billiton (2005) Annual Report 2005. INTERNET http://www.bhpbilliton.com/~/media/bhp/documents/investors/reports/2005/bhpb_ltd_concise_ar05.pdf?la=en Cited 10 July 2016.

BHP Billiton (2006) Annual Report 2006. INTERNET http://www.bhpbilliton.com/~/media/bhp/documents/investors/reports/2006/bhpbreview2006.pdf?la=en Cited 10 July 2016.

BHP Billiton (2007) Annual Report 2007. INTERNET http://www.bhpbilliton.com/~/media/bhp/documents/investors/reports/2007/bhpbannualreview07.pdf?la=en Cited 10 July 2016.

BHP Billiton (2008) Annual Report 2008. INTERNET http://www.bhpbilliton.com/~/media/bhp/documents/investors/reports/2008/annualreport2008.pdf?la=en Cited 10 July 2016.

BHP Billiton (2009) Annual Report 2009. INTERNET http://www.bhpbilliton.com/~/media/bhp/documents/investors/reports/2009/annualreport2009.pdf?la=en Cited 10 July 2016.

BHP Billiton (2010) Annual Report 2010. INTERNET http://www.bhpbilliton.com/~/media/bhp/documents/investors/reports/2010/bhpbillitonannualreport2010.pdf?la=en Cited 10 July 2016.

BHP Billiton (2011) Annual Report 2011. INTERNET http://www.bhpbilliton.com/~/media/bhp/documents/investors/reports/2011/bhpbillitonannualreport2011.pdf?la=en Cited 10 July 2016.

BHP Billiton (2012) Annual Report 2012. INTERNET http://www.bhpbilliton.com/~/media/bhp/documents/investors/reports/2012/bhpbillitonannualreport2012.pdf?la=en Cited 10 July 2016.

BHP Billiton (2013) Annual Report 2013. INTERNET http://www.bhpbilliton.com/~/media/bhp/documents/investors/reports/2013/bhpbillitonannualreport2013.pdf?la=en Cited 10 July 2016.

BHP Billiton (2014a) Creation of new global metals and mining company to accelerate portfolio simplification. INTERNET http://www.bhpbilliton.com/investors/news/creation-of-new-global-metals-and-mining-company Cited 14 September 2016.

BHP Billiton (2014b) Annual report 2014. INTERNET http://www.bhpbilliton.com/~/media/bhp/documents/investors/reports/2014/bhpbillitonannualreport2014_interactive.pdf?la=en Cited 10 July 2016.

BHP Billiton (2015) Annual report 2015. INTERNET http://www.bhpbilliton.com/~/media/bhp/documents/investors/annual-reports/2015/bhpbillitonannualreport2015.pdf?la=en Cited 10 July 2016.

BHP Billiton (2016a) Our history. INTERNET http://www.bhpbilliton.com/aboutus/ourcompany/ourhistory Cited 14 September 2016.

BHP Billiton (2016b) About us; Our strategy delivers. INTERNET http://www.bhpbilliton.com/aboutus/strategy Cited 14 September 2016.

Bhullar, P.S. & Bhatnagar, D. (2013) Theoretical framework : EV vs Stock price – A better measurement of firm value. International Journal of Commerce, Business and Management. Vol 2 No. 6. 335 – 343.

Biesheuvel, T. & Crowley K. (2015) Anglo overtakes Glencore as worst performing FTSE-100 stock. INTERNET http://www.bloomberg.com/news/articles/2015-12-09/anglo-draws-level-with-glencore-as-worst-stock-in-u-k-ftse-100 Cited 10 September 2016.

Brahmbhatt, M. & Canuto, O. (2010) Natural resources and development strategy after the crisis. Economic Premise No. 1. Washington DC: World Bank.

Damodaran, A. (2007) Return on Capital (ROC), Return on Invested Capital (ROIC) and Return on Equity (ROE): Measurement and Implications, New York: Stern School of Business.

Deloitte (2012) Linking strategy to value. Journal of business strategy, Vol 33 Issue 4, 49-57.

Deloitte (2016a) Mineral asset valuations. INTERNET https://www2.deloitte.com/za/en/pages/energy-and-resources/articles/life-cycle-2-valutions.html Cited 28 November 2016.

Deloitte (2016b) Tracking the trends 2016 – The top 10 issues mining companies will face in the coming year. INTERNET https://www2.deloitte.com/content/dam/Deloitte/global/Documents/Energy-and-Resources/gx-er-tracking-the-trends-2016.pdf Cited 12 July 2016.

Diamond Search Engine (2016) Diamond Trends Price Index. INTERNET http://www.diamondse.info/diamonds-price-index.asp Cited 5 July 2016.

Ernst & Young (2015) Debt in the mining sector. EY Global Mining & Metals Network, London.

Ellis, T.R. (2016) Comparable mineral properties – do they exist for market value appraisals, Mining Engineering Vol 68 No 5, 67-72.

Fernàndez, P. (2007) Company valuation methods – the most common errors in valuations; IESE Business School – University of Navarra Working Paper no 449, Barcelona.

FTSE Russell (2016) FTSE gold mines index series. INTERNET http://www.ftse.com/products/indices/Gold Cited 8 July 2016.

FXtop (2016) Major historic exchange rates. INTERNET http://fxtop.com/en/historical-exchange-rates.php Cited 1 September 2016.

Investopedia (2016a) Business valuation. INTERNET http://www.investopedia.com/terms/b/business-valuation.asp Cited 3 October 2016.

Investopedia (2016b) Enterprise value (EV), INTERNET http://www.investopedia.com/terms/e/enterprisevalue.asp Cited 1 September 2016

Krinks, P., Nieponice, G., King, T., Scheibehenne, V. & Vogt, T. (2011) Value Creating in Mining – More than Commodity Prices: The 2010 Value Creators Report, Boston: Boston Consulting Group.

Koller, T., Goedhart, M., & Wessels, D. (2005) Valuation: Measuring and managing the value of companies, 4th Ed., New Jersey: John Wiley & Sons.

Laerd Statistics (2016) Pearson Product-Moment Correlation. INTERNET https://statistics.laerd.com/statistical-guides/pearson-correlation-coefficient-statistical-guide.php Cited 13 October 2016.

L.E.K Consulting (nd) Identifying and managing key value drivers, Executive Insights. Vol. 1, Iss. 1.

Loughran, T. & Wellman, J.W. (2010) New evidence on the relation between the enterprise multiple and average stock returns. Journal of Financial and Quantitative Analysis, Vol 46 No. 6, 1629 – 1650.

Macabacus (2016) Valuation multiples, INTERNET http://macabacus.com/valuation/multiples Cited 4 October 2016.

Maverick, J.B. (2015) What main factors affect share prices in the metals and mining sector. INTERNET http://www.investopedia.com/ask/answers/022615/what-main-factors-affect-share-prices-metals-and-mining-sector.asp Cited viewed 5 July 2016.

Maxwell, P. (2006) Mineral economics – an introduction. Monograph 24 – Australian Mineral Economics, Sydney: Australian Institute of Mining and Metallurgy.

Media, T. (2012) Understanding commodity super-cycles, INTERNET http://www.troymedia.com/2012/05/15/understanding-commodity-super-cycles/ Cited 11 December 2016.

Minerals Council of Australia (2015) Iron Ore & global markets. INTERNET http://www.ironorefacts.com/the-facts/iron-ore-global-markets/ Cited 14 September 2016.

NACVA (National Association of Certified Valuators and Analyst) (2008) Business valuations: Fundamentals, techniques and theory, Salt Lake City: NACVA.

Njowa, G., Clay, A.N., & Musingwini, C. (2013) A perspective on global harmonisation of major national mineral asset valuation codes, Resources Policy Vol. 39, 1 – 14.

Oxford Dictionary (2016) Value INTERNET https://en.oxforddictionaries.com/definition/value Cited 25 October 2016.

Pattabiraman, S. (2013) Growth vs profitability, The importance of ROCE. CFO Connect. March 2013. India.

Pederson, J.P. (2005) International directory of company histories. Vol 67. London: St James Press.

Price Waterhouse Coopers (2006) Mines 2006 - Let the good times roll. INTERNET https://www.pwc.com/ua/en/press-room/assets/pwc_mine_2006.pdf Cited 13 July 2016.

Price Waterhouse Coopers (2007) Mine 2007 – Riding the wave. INTERNET https://www.pwc.co.za/en/assets/pdf/pwc-mining-review-07.pdf Cited 13 July 2016.

Price Waterhouse Coopers (2009) Mines 2009 - When the going gets tough…. INTERNET http://www.infomine.com/library/publications/docs/PricewaterhouseCoopers2009.pdf Cited 13 July 2016.

Price Waterhouse Coopers (2010) Mines 2010 – Back to the boom. INTERNET http://www.pwc.co.za/en/assets/pdf/mine-2010-back-to-the-boom.pdf Cited 13 July 2016.

Price Waterhouse Cooper (2011) Mines 2011 – The game has changed. INTERNET http://www.pwc.com/ua/en/industry/metal_mining/mining/publications/mine-2011.html Cited 13 July 2016.

Price Waterhouse Cooper (2012) Mines 2012 – The growing disconnect. INTERNET https://www.pwc.kz/en/publications/mine/mine-2012-eng.pdf Cited 13 July 2016.

Price Waterhouse Coopers (2013) Mine 2013 A confidence crisis. INTERNET https://www.pwc.com/gx/en/mining/publications/assets/pwc-mine-a-confidence-crisis.pdf Cited 13 July 2016.

Price Waterhouse Coopers (2015) Sustainable cost reduction in the mining sector. INTERNET https://www.pwc.com/ca/en/mining/publications/cost-reduction-mining-sector-2010-11-30-en.pdf Cited 13 July 2016.

Price Waterhouse Coopers (2016) Mines 2016 – Slower, lower, weaker .. but not defeated. INTERNET https://www.pwc.co.za/en/assets/pdf/mine-2016.pdf Cited 13 July 2016.

Rio Tinto (2006) Annual Report 2005. INTERNET http://www.portalchemy.com/Report.asp?ShareCode=RIO.L&arYear=2005 Cited 15 July 2016.

Rio Tinto (2007) Annual Report 2006. INTERNET https://bib.kuleuven.be/files/ebib/jaarverslagen/RioTinto_2006.pdf Cited 15 July 2016.

Rio Tinto (2008) Annual Report 2007. INTERNET http://www.riotinto.com/annualreport2007/services/downloads/index.html Cited 15 July 2016.

Rio Tinto (2009) Annual Report 2008. INTERNET http://www.riotinto.com/documents/AnnualReport2008.pdf Cited 15 July 2016.

Rio Tinto (2010) Annual Report 2009. INTERNET http://www.riotinto.com/documents/rio_tinto_full_annualreport2009.pdf Cited 15 July 2016.

Rio Tinto (2011) Annual Report 2010. INTERNET http://www.riotinto.com/documents/riotinto_2010_ara.pdf Cited 15 July 2016.

Rio Tinto (2012) Annual Report 2011. INTERNET http://www.riotinto.com/documents/Investors/Rio_Tinto_2011_Annual_report.pdf Cited 15 July 2016.

Rio Tinto (2013) Annual Report 2012. INTERNET http://www.riotinto.com/documents/rio_tinto_2012_annual_report.pdf Cited 15 July 2016.

Rio Tinto (2014) Annual Report 2013. INTERNET http://www.riotinto.com/documents/RT_Annual_report_2013.pdf Cited 15 July 2016.

Rio Tinto (2015) Annual Report 2014. INTERNET http://www.riotinto.com/documents/RT_Annual_report_2014.pdf Cited 15 July 2016.

Rio Tinto (2016a) Annual Report 2015. INTERNET http://www.riotinto.com/documents/RT_Annual_Report_2015.pdf Cited 15 July 2016.

Rio Tinto (2016b) History. INTERNET http://www.riotinto.com/aboutus/history-4705.aspx Cited 16 September 2016.

Roberts, C. (2006) The valuation of advanced mining projects and operating mines: market comparable approaches. INTERNET www.infomine.com/library/publications/docs/roberts2006.pdf Cited 15 July 2016.

South African Mineral Asset Valuation Committee (SAMVAL), (2016), The South African code for reporting of mineral asset valuation. INTERNET http://www.samcode.co.za/samcode-ssc/samval Cited 9th June 2017.

Seccombe, A. (2015) Minas Rio aims to cut output costs, Business Day INTERNET http://www.bdlive.co.za/business/mining/2015/05/13/minas-rio-aims-to-cut-output-costs Cited 1 September 2016.

Solly, I. (2013) Glencore Xstrata – The birth of a mining monster, London Mining Network Briefing paper – October 2013, INTERNET www.londonminingnetwork.org/wp-content/.../Glencore-Xstrata-merger-final-1310041.doc Cited 5 September 2016.

South 32 (2015) Annual Report 2015. INTERNET https://www.south32.net/CMSPages/GetFile.aspx?guid=a9c4ef48-785c-4ebb-9150-e7e96cb1005a Cited 20 July 2016.

Spector, J.B. (2012) Anglo American: A giant corporation between a big rock and a very hard place, Daily Maverick. INTERNET http://www.dailymaverick.co.za/article/2012-10-29-anglo-american-a-giant-corporation-between-a-big-rock-and-a-very-hard-place/#.V9gH3_l97IU Cited 13 September 2016.

Steiger, F. (2008) The validity of company valuation using discounted cash flow methods. European Business School.

The Steel index (2016) Coking coal index. INTERNET https://www.thesteelindex.com/en/cokingcoalindex/ Cited 10 October 2016.

Vale (2006) Annual Report Form 20-F 2005. INTERNET http://www.vale.com/EN/investors/information-market/annual-reports/20f/20FDocs/20F_2005_i.pdf Cited 12 July 2016.

Vale (2007) Annual Report Form 20-F 2006. INTERNET http://www.vale.com/EN/investors/information-market/annual-reports/20f/20FDocs/20F_2006_i.pdf Cited 12 July 2016.

Vale (2008) Annual Report Form 20-F 2007. INTERNET http://www.vale.com/EN/investors/information-market/annual-reports/20f/20FDocs/20F_2007_i.pdf Cited 12 July 2016.

Vale (2009) Annual Report Form 20-F 2008. INTERNET http://www.vale.com/EN/investors/information-market/annual-reports/20f/20FDocs/20F_2008_i.pdf Cited 12 July 2016.

Vale (2010) Annual Report Form 20-F 2009. INTERNET http://www.vale.com/EN/investors/information-market/annual-reports/20f/20FDocs/20F_2009_i.pdf Cited 12 July 2016.

Vale (2011) Annual Report Form 20-F 2010. INTERNET http://www.vale.com/EN/investors/information-market/annual-reports/20f/20FDocs/20F_2010_i.pdf Cited 12 July 2016.

Vale (2012a) Vale – Our history. Sao Paulo: Vale Brazil.

Vale (2012b) Annual Report Form 20-F 2011. INTERNET http://www.vale.com/EN/investors/information-market/annual-reports/20f/20FDocs/20F_2011_i.pdf Cited 12 July 2016.

Vale (2013) Annual Report Form 20-F 2012. INTERNET http://www.vale.com/EN/investors/information-market/annual-reports/20f/20FDocs/20F_2012_i.pdf Cited 12 July 2016.

Vale (2014) Annual Report Form 20-F 2013. INTERNET http://www.vale.com/EN/investors/information-market/annual-reports/20f/20FDocs/20F_2013_i.pdf Cited 12 July 2016.

Vale (2015) Annual Report Form 20-F 2014. INTERNET http://www.vale.com/EN/investors/information-market/annual-reports/20f/20FDocs/Vale%2020-F%202014_i_novo.pdf Cited 12 July 2016.

Vale (2016) Annual Report Form 20-F 2015. INTERNET http://www.vale.com/EN/investors/information-market/annual-reports/20f/20FDocs/Vale%2020-F%202015_i.PDF Cited 12 July 2016.

Wilson, J. (2016) Anglo American eases executive bonus target, Financial Times. INTERNET https://www.ft.com/content/872490d2-dca5-11e5-827d-4dfbe0213e07 Cited 20 September 2016.

World Bank (2016) Commodity prices “Pink sheet”. INTERNET http://www.worldbank.org/en/research/commodity-markets#1 Cited 1 September 2016.

Yahoo Finance (2016a) Anglo American plc LSE historic share price. INTERNET https://uk.finance.yahoo.com/q/hp?s=AAL.L Cited 1 September 2016.

Yahoo Finance (2016b) BHP Billiton ASX historic share price. INTERNET https://uk.finance.yahoo.com/q/hp?s=BHP.AX Cited 1 September 2016.

Yahoo Finance (2016c) Rio Tinto LSE historic share price. INTERNET https://uk.finance.yahoo.com/q/hp?s=RIO.L Cited 1 September 2016.

Yahoo Finance (2016d) Rio Tinto LSE historic share price. INTERNET https://uk.finance.yahoo.com/q/hp?s=VALE Cited 1 September 2016.

7 APPENDICES

Appendix 7.1 : Company sector summary - Anglo American

Source : Anglo American (2006 – 2016)

Company	Commodity grouping	Sector summary	Commodity for production analysis	Commodity price for revenue analysis
Anglo American	Platinum group metals	Mining of platinum, palladium, rhodium and by-product of copper, nickel and gold	Refined platinum production in ounces	Platinum price ($/oz)
	Gold	Mining of gold	Gold production in ounces	Gold price ($/oz)
	Diamonds	Mining of diamonds	Diamond production in carats	Diamond index price ($/ct)
	Coal	Includes both metallurgical and thermal coal	Total coal output including Australian metallurgical coal, Australian thermal coal, South African export thermal coal and South African domestic coal pricing	50% thermal coal & 50% coking coal (derived from the years that the company did report revenue split for thermal & coking coal, where the contribution was close to 50% from each)
	Copper	Copper output in tonnes	Copper output in tonnes	Copper price ($/mt)
	Nickel, niobium & mineral sands	Mining of nickel, niobium and phosphates niobium	This will be represented by nickel output in '000 tonnes	Nickel price ($/mt)
	Iron ore & manganese	Mining of iron ore and manganese	Total iron ore production including lump and fines in million tonnes	Iron ore cfr ($/dmtu)
	Other mining, industrial & corporate	Includes zinc, Scaw metals, Highveld steel, Samancor (manganese), Tongaat-Hulett (sugar & aluminium)	No production analysis to occur for this	N/A

Appendix 7.2 : Company sector summary - BHP Billiton

Source : BHP Billiton (2005 – 2016) & South 32 (2015)

Company	Commodity grouping	Sector summary	Commodity for production analysis	Commodity price for revenue analysis
BHP Billiton	Petroleum & potash	Exploration, development and production of oil and gas & potash	Total petroleum output which includes crude oil, condensate and natural gas liquids and natural gas in million barrels of oil equivalent (boe). Since potash is a minor contributor it is not included in the production analysis	Crude oil average ($/bbl)
	Aluminium, manganese & nickel	Mining of bauxite, refining of bauxite into alumina and smelting of alumina into aluminium metal. Mining of manganese ore and production of manganese metal and alloys. Mining & production of nickel products	Aluminium is the main output and contributor to revenue for this sector the total aluminium output in '000 tonnes will be used for the production analysis	Aluminium ($/mt)
	Base metals	Mining of copper, silver, lead, zinc, molybdenum, uranium and gold.	Copper is the main contributor to revenue for this sector. Measured in '000 tonnes	Copper ($/mt)
	Diamond and speciality productions	Mining of diamonds and titanium minerals	Diamond carats produced	Diamond index price ($/ct)
	Iron ore	Mining of iron ore	Iron ore in '000 tonnes	Iron ore cfr ($/dmtu)
	Metallurgical coal	Mining of metallurgical coal	Metallurgical coal in '000 tonnes	Australian HCC coal FOB ($/t)
	Energy coal	Mining of thermal (energy) coal	Energy (thermal) coal in '000 tonnes	Australian thermal coal FOB ($/t)

Appendix 7.3 : Company sector summary - Rio Tinto

Source : Rio Tinto (2006 – 2016a)

Company	Commodity grouping	Sector summary	Commodity for production analysis	Commodity price for revenue analysis
Rio Tinto	Aluminium	Mining of bauxite, refining of bauxite into alumina and smelting of alumina into aluminium metal.	Aluminium is the main output and contributor to revenue for this sector the total aluminium output in '000 tonnes will be used for the production analysis.	Aluminium ($/mt)
	Iron ore	Mining of iron ore	Iron ore in '000 tonnes	Iron ore cfr ($/dmtu)
	Diamonds & industrial minerals	Mining of diamonds, Rio Tinto Iron and Titanium division (RTIT) which produces titanium dioxide, Rio Tinto Minerals & Dampier salt	As over 50% of this sectors revenue is from titanium dioxide since titanium dioxide price history is difficult to obtain, diamonds will be used	Diamonds ($/ct)
	Copper	Mining of copper	Copper in '000 tonnes	Copper ($/mt)
	Energy	Mining of thermal coal and uranium.	Majority of revenue from thermal coal thus total thermal coal output used.	Australian thermal coal FOB ($/t)

Appendix 7.4 : Company sector summary - CVRD-Vale

Source : Vale (2006 – 2016)

Company	Commodity grouping	Sector summary	Commodity for production analysis	Commodity price for revenue analysis
CVRD-Vale	Ferrous metals	Mining of iron ore, pellets, ferroralloys and managanese	Iron ore in '000 tonnes	Iron ore cfr ($/dmtu)
	Coal	Mining of thermal coal	Thermal coal in '000 tonnes	Australian Thermal coal FOB ($/t)
	Base metals	Mining of nickel and other products	Nickel in '000 tonnes	Nickel ($/mt)
	Copper	Mining of copper	Copper in '000 tonnes	Copper ($/mt)
	Fertilizers	Mining of potash, phosphates nitrogen and other fertilizer products	Phosphate rock in '000 tonnes	Phosphate rock ($/mt)
	Aluminium	Mining of bauxite, aluminium trading activities, alumina refining and aluminium metal smelting	Bauxite is the main output and contributor for revenue for this sector. Total bauxite output in '000 tonnes	Aluminium ($/mt)
	Logistics & others	Large logistics systems in Brazil including railroads, maritime terminals and a port	N/A	N/A

Appendix 7.5 : Economic data – Anglo American

Source : Anglo American (2006 – 2016) & Yahoo Finance (2016a)

	EV	EBITDA	EBITDA annual	Group revenue (6 mth)	Group revenue (12 mth)	Net debt	Gearing	Group attributable ROCE	EBITDA to revenue	EBITDA to annual revenue	Net debt to EBITDA	EV/ EBITDA
Dec-15	$ 19,191	$ 1,139	$ 4,419	$9,657	$23,003	$12,901	37.7%	5.0%	12%	0.2	2.9	4.34
Jun-15	$ 33,553	$ 3,280		$13,346		$13,500	32.8%	8.0%	25%			
Dec-14	$ 39,106	$ 2,776	$ 7,104	$14,844	$30,988	$12,871	28.6%	9.0%	19%	0.2	1.8	5.50
Jun-14	$ 44,427	$ 4,328		$16,144		$10,652	23.1%	10.0%	27%			
Dec-13	$ 40,793	$ 4,445	$ 8,806	$16,870	$33,063	$10,652	22.2%	11.0%	26%	0.3	1.2	4.63
Jun-13	$ 37,309	$ 4,361		$16,193		$ 9,756	19.6%	11.0%	27%			
Dec-12	$ 51,045	$ 2,925	$ 7,867	$16,377	$32,785	$ 8,510	16.4%	13.3%	18%	0.2	1.1	6.49
Jun-12	$ 48,277	$ 4,942		$16,408		$ 3,124	6.5%	14.0%	30%			
Dec-11	$ 50,417	$ 6,236	$ 13,348	$18,254	$36,548	$ 1,374	3.1%	26.5%	34%	0.4	0.1	3.78
Jun-11	$ 73,037	$ 7,112		$18,294		$ 6,794	3.1%	26.3%	39%			
Dec-10	$ 76,099	$ 6,569	$ 11,983	$17,914	$32,929	$ 7,384	16.3%	24.8%	37%	0.4	0.6	6.35
Jun-10	$ 56,731	$ 5,414		$15,015		$10,930	26.6%	18.5%	36%			
Dec-09	$ 69,239	$ 3,945	$ 6,930	$13,505	$24,637	$11,328	28.7%	14.6%	29%	0.3	1.6	9.99
Jun-09	$ 49,314	$ 2,985		$11,132		$11,335	33.1%	15.2%	27%			
Dec-08	$ 41,266	$ 4,809	$ 11,847	$15,049	$32,964	$11,043	34.3%	36.8%	32%	0.4	0.9	3.48
Jun-08	$ 96,641	$ 7,038		$17,915		$ 5,400	16.6%	36.9%	39%			
Dec-07	$ 87,379	$ 5,532	$ 12,132	$10,710	$30,559	$ 5,239	16.6%	37.8%	52%	0.4	0.4	7.20
Jun-07	$ 82,644	$ 6,600		$19,849		$ 5,300	20.1%	37.3%	33%			
Dec-06	$ 69,878	$ 6,341	$ 12,197	$10,579	$29,404	$ 3,324	10.3%	25.3%	60%	0.4	0.3	5.73
Jun-06	$ 58,341	$ 5,856		$18,825		$ 2,700	11.0%	21.7%	31%			
Dec-05	$ 52,621	$ 4,710	$ 8,959	$17,327	34,472	$ 4,993	17.0%	19.2%	27%	0.3	0.6	5.87

Appendix 7.6 : Economic data – BHP Billiton

Source : BHP Billiton (2005 – 2015), South 32 (2015) & & Yahoo Finance (2016b)

	EV	EBITDA	EBITDA annual	Group revenue (6 mth)	Group revenue (12 mth)	Net debt	Gearing	Group attributable ROCE	EBITDA to revenue	EBITDA to annual revenue	Net debt to EBITDA	EV/ EBITDA
Dec-15	$72,120	$5,994		$19,801		$26,016	25.3%		30%			
Jun-15	$99,601	$15,101	$29,595	$22,479	$52,379	$24,819	24.0%	4.9%	67%	57%	0.8	3.37
Dec-14	$96,939	$14,494		$29,900		$24,900	22.4%		48%			
Jun-14	$127,375	$13,774	$30,292	$33,258	$67,206	$25,786	23.2%	15.8%	41%	45%	0.9	4.20
Dec-13	$128,868	$16,518		$33,948		$27,100	32.9%		49%			
Jun-13	$115,163	$14,865	$28,109	$33,764	$65,968	$29,105	28.8%	23.0%	44%	43%	1.0	4.10
Dec-12	$146,140	$13,244		$32,204		$30,400	31.0%		41%			
Jun-12	$120,154	$12,811	$31,554	$19,140	$56,620	$23,607	26.0%	13.5%	67%	56%	0.7	3.81
Dec-11	$127,123	$18,743		$37,480		$21,500	25.0%		50%			
Jun-11	$146,803	$15,600	$32,904	$22,922	$57,088	$5,823	9.2%	42.8%	68%	58%	0.2	4.46
Dec-10	$146,691	$17,304		$34,166		$7,915	6.0%		51%			
Jun-10	$102,652	$13,675	$24,513	$28,222	$52,798	$3,308	6.3%	26.4%	48%	46%	0.1	4.19
Dec-09	$129,581	$10,838		$24,576		$7,915	15.1%		44%			
Jun-09	$93,592	$4,275	$18,214	$20,431	$50,211	$5,586	12.1%	24.6%	21%	36%	0.3	5.14
Dec-08	$71,534	$13,939		$29,780		$4,168	9.5%		47%			
Jun-08	$139,934	$16,864	$28,031	$33,934	$59,473	$8,458	17.8%	37.5%	50%	47%	0.3	4.99
Dec-07	$122,762	$11,167		$25,539		$12,200	28.0%		44%			
Jun-07	$103,204	$10,633	$21,127	$25,359	$47,473	$9,971	25.0%	38.4%	42%	45%	0.5	4.88
Dec-06	$69,757	$10,494		$22,114		$7,200	20.3%		47%			
Jun-06	$75,819	$17,098	$25,069	$21,019	$39,099	$8,200	27.2%	36.6%	81%	64%	0.3	3.02
Dec-05	$62,767	$7,971		18,080		$8,700	25.2%		44%			
NB: 2015 data includes reported data from South 32 Annual reports												

Appendix 7.7 : Economic data – Rio Tinto

Source : Rio Tinto (2006 – 2016a) & Yahoo Finance (2016c)

	EV	EBITDA	EBITDA annual	Group revenue (6 mth)	Group revenue (12 mth)	Net debt	Gearing	Group attributable ROCE	EBITDA to revenue	EBITDA to annual revenue	Net debt to EBITDA	EV/ EBITDA
Dec-15	$67,902	$4,755	$12,058	$17,551	$36,785	$13,783	23.8%	4.9%	27%	33%	1.1	5.63
Jun-15	$88,536	$7,303		$19,234		$13,683	21.3%		38%			
Dec-14	$99,239	$8,387	$18,840	$24,476	$50,041	$12,495	18.6%	13.1%	34%	38%	0.7	5.27
Jun-14	$109,628	$10,453		$25,565		$12,495	18.6%		41%			
Dec-13	$121,222	$10,799	$20,953	$28,009	$54,599	$18,055	25.2%	8.3%	39%	38%	0.9	5.79
Jun-13	$98,878	$10,154		$26,590		$22,105	28.3%		38%			
Dec-12	$124,023	$9,484	$20,095	$27,774	$55,566	$19,192	24.9%	-1.8%	34%	36%	1.0	6.17
Jun-12	$106,153	$10,611		$27,792		$19,192	22.7%		38%			
Dec-11	$102,094	$14,221	$28,521	$36,298	$65,354	$8,451	12.5%	13.4%	39%	44%	0.3	3.58
Jun-11	$150,505	$14,300		$29,056		$8,589	11.0%		49%			
Dec-10	$141,382	$14,722	$25,978	$28,403	$55,171	$4,071	5.9%	20.7%	52%	47%	0.2	5.44
Jun-10	$97,887	$11,256		$26,768		$11,967	20.0%		42%			
Dec-09	$115,906	$8,223	$14,312	$24,513	$44,036	$18,861	29.1%	9.5%	34%	33%	1.3	8.10
Jun-09	$93,168	$6,089		$19,523		$39,057	67.3%		31%			
Dec-08	$67,381	$12,462	$23,870	$28,060	$58,065	$38,672	63.3%	16.1%	44%	41%	1.6	2.82
Jun-08	$167,398	$11,408		$30,005		$42,127	55.6%		38%			
Dec-07	$159,123	$6,998	$13,611	$19,588	$33,518	$45,191	63.2%	12.4%	36%	41%	3.3	11.69
Jun-07	$84,159	$6,613		$13,930		$2,862	11.5%		47%			
Dec-06	$61,211	$7,066	$12,566	$13,440	$25,440	$2,437	11.2%	36.1%	53%	49%	0.2	4.87
Jun-06	$61,214	$5,500		$12,000		$2,623	13.8%		46%			
Dec-05	$54,219	$9,743	$9,743	$20,742	20,742	$1,313	7.7%	30.8%	47%	47%	0.1	5.56

Appendix 7.8 : Economic data – CVRD-Vale

Source : Vale (2006 – 2016) & Yahoo Finance (2016d)

	EV	EBITDA	EBITDA annual	Group revenue (6 mth)	Group revenue (12 mth)	Net debt	Gearing	Group attributable ROCE	EBITDA to revenue	EBITDA to annual revenue	Net debt to EBITDA	EV/ EBITDA
Dec-15	$42,215	$3,266	$7,081	$12,404	$25,609	$25,262	41.4%	-7.9%	26%	28%	3.6	5.96
Jun-15	$56,966	$3,815		$13,205		$26,615	34.8%		29%			
Dec-14	$66,985	$5,191	$13,353	$18,134	$37,539	$24,833	30.6%	6.8%	29%	36%	1.9	5.02
Jun-14	$90,971	$8,162		$19,405		$22,797	25.0%		42%			
Dec-13	$102,707	$12,793	$22,679	$26,083	$48,050	$24,124	27.1%	12.9%	49%	47%	1.1	4.53
Jun-13	$91,556	$9,886		$21,967		$23,794	24.9%		45%			
Dec-12	$132,715	$7,728	$17,642	$23,673	$47,694	$24,708	24.8%	7.8%	33%	37%	1.4	7.52
Jun-12	$123,138	$9,914		$24,021		$20,851	20.3%		41%			
Dec-11	$128,833	$16,582	$34,234	$32,744	$60,946	$19,502	19.7%	25.6%	51%	56%	0.6	3.76
Jun-11	$177,841	$17,652		$28,202		$11,126	11.2%		63%			
Dec-10	$197,216	$16,772	$24,955	$30,767	$47,029	$16,830	19.0%	19.5%	55%	53%	0.7	7.90
Jun-10	$145,611	$8,183		$16,262		$16,848	20.9%		50%			
Dec-09	$171,255	$5,302	$9,165	$13,039	$23,311	$15,538	20.6%	6.5%	41%	39%	1.7	18.69
Jun-09	$103,132	$3,863		$10,272		$11,244	17.7%		38%			
Dec-08	$69,138	$9,342	$19,018	$8,481	$27,426	$7,837	15.0%	20.3%	110%	69%	0.4	3.64
Jun-08	$194,335	$9,676		$18,945		$18,136	30.3%		51%			
Dec-07	$177,404	$7,533	$15,774	$16,061	$32,242	$17,811	34.9%	19.8%	47%	49%	1.1	11.25
Jun-07	$232,976	$8,241		$16,181		$17,265	37.2%		51%			
Dec-06	$162,134	$5,345	$9,150	$12,877	$20,363	$18,133	48.0%	14.2%	42%	45%	2.0	17.72
Jun-06	$120,301	$3,805		$7,486		$3,899	18.5%		51%			
Dec-05	$202,027	$6,540	$6,540	$13,405	13,405	$3,969	24.9%	28.1%	49%	49%	0.6	30.89

Appendix 7.9 : Quarterly production output – Anglo American

Source : Anglo American (2006 – 2016)

	Copper (t)	Nickel (t)	Iron ore (Mt)	Coal (Mt)	PGM's (koz)	Diamonds (Mct)	Gold (oz)
Dec 05	158,750	5,225	7.8	14.7	626	12.3	1,542
Mar 06	163,800	6,600	7.8	23.7	716	12.8	829
Jun 06	163,800	6,600	7.8	23.7	716	12.8	829
Sep 06	163,800	6,600	7.8	23.7	716	12.8	829
Dec 06	163,800	6,600	7.8	23.7	716	12.8	829
Mar 07	146,387	6,462	7.6	22.9	638	12.6	556
Jun 07	170,300	6,200	7.8	25.7	611	13.7	556
Sep 07	170,300	6,200	7.8	25.7	611	13.7	-
Dec 07	176,400	6,500	9.0	23.6	669	12.1	-
Mar 08	159,700	4,600	8.2	22.3	518	11.8	-
Jun 08	161,000	5,000	8.9	25.8	573	12.5	-
Sep 08	148,600	5,600	10.3	25.7	543	13.1	-
Dec 08	172,000	4,800	10.1	25.7	842	10.8	-
Mar 09	151,000	4,500	10.0	22.2	404	1.1	-
Jun 09	165,900	5,600	10.3	25.0	652	5.5	-
Sep 09	168,500	4,900	11.9	26.2	629	7.9	-
Dec 09	185,900	4,900	12.4	23.7	604	10.1	-
Mar 10	160,800	4,800	12.3	22.4	595	7.0	-
Jun 10	154,700	5,300	11.5	24.0	601	8.4	-
Sep 10	153,400	5,700	11.8	26.2	648	9.0	-
Dec 10	154,400	4,400	11.8	25.3	640	8.5	-
Mar 11	138,800	6,100	9.9	21.1	568	7.4	-
Jun 11	144,500	6,000	11.5	23.7	593	8.1	-
Sep 11	154,000	7,000	12.2	24.9	667	4.2	-
Dec 11	170,000	9,900	12.4	25.5	583	6.5	-
Mar 12	155,200	10,800	11.7	22.3	93	2.8	-
Jun 12	160,020	12,600	12.9	25.4	584	3.3	-
Sep 12	157,300	7,600	12.5	25.9	626	6.4	-
Dec 12	172,900	7,400	9.0	25.8	416	8.1	-
Mar 13	170,500	6,200	10.3	22.3	583	6.4	-
Jun 13	176,700	6,300	11.3	25.0	595	7.9	-
Sep 13	207,300	9,500	9.5	26.7	623	7.7	-
Dec 13	214,400	10,200	11.3	24.8	520	9.1	-
Mar 14	202,000	9,200	11.3	22.8	357	7.5	-
Jun 14	194,400	10,600	11.5	12.9	358	8.5	-
Sep 14	176,900	10,700	13.0	14.1	514	8.2	-
Dec 14	174,800	6,700	13.1	25.8	594	8.4	-
Mar 15	171,800	6,700	13.4	24.0	536	7.7	-
Jun 15	184,500	6,300	12.2	13.9	572	8.0	-
Sep 15	171,500	6,800	14.3	14.3	614	6.0	-
Dec 15	181,400	10,500	14.2	22.5	598	7.1	-

Appendix 7.10 : Quarterly production output – BHP Billiton

Source : BHP Billiton (2005 – 2015) & South 32 (2015)

	Petroleum (Mbbl)	Aluminium (kt)	Base metals (kt)	Diamonds (kct)	Iron ore (Mt)	Met. coal (Mt)	Energy coal (Mt)
Dec-05	29	341	317	640	24.26	8.91	21.43
Mar-06	26	329	294	512	21.12	8.46	18.67
Jun-06	31	344	312	583	26.11	9.22	21.79
Sep-06	31	337	250	487	25.00	9.24	21.78
Dec-06	28	338	301	937	25.37	8.96	22.03
Mar-07	28	331	358	889	22.88	9.08	20.93
Jun-07	30	334	342	911	25.74	11.13	21.23
Sep-07	30	337	308	1,022	25.86	9.57	19.62
Dec-07	30	338	348	843	27.74	9.64	20.61
Mar-08	33	318	329	620	28.41	6.84	16.39
Jun-08	36	305	391	864	29.92	9.13	18.72
Sep-08	35	309	309	773	29.82	9.21	18.06
Dec-08	33	310	308	594	29.35	10.15	16.48
Mar-09	32	304	283	951	28.18	7.59	15.22
Jun-09	38	310	307	903	27.04	9.46	17.71
Sep-09	41	313	284	780	30.10	9.40	18.06
Dec-09	39	313	271	760	32.44	8.89	15.46
Mar-10	37	306	229	770	31.16	8.15	16.34
Jun-10	41	309	291	740	31.24	10.92	16.27
Sep-10	43	314	291	703	31.98	10.29	17.11
Dec-10	37	314	302	676	33.66	7.78	16.51
Mar-11	36	305	274	551	33.23	6.67	6.67
Jun-11	43	313	272	576	35.52	7.92	18.34
Sep-11	51	315	220	457	39.57	9.29	18.46
Dec-11	58	313	280	481	41.07	8.49	16.92
Mar-12	57	277	281	433	37.94	7.33	17.24
Jun-12	56	248	313	413	40.89	8.10	18.48
Sep-12	61	270	274	313	39.77	8.93	19.61
Dec-12	60	297	295	295	42.19	8.88	18.26
Mar-13	55	303	434	322	40.20	8.96	16.00
Jun-13	59	310	462	-	47.68	10.85	18.56
Sep-13	63	310	403	-	48.84	10.18	19.64
Dec-13	58	302	440	-	48.86	11.54	17.77
Mar-14	61	286	414	-	49.56	11.46	17.72
Jun-14	65	276	470	-	56.64	11.88	18.36
Sep-14	67	261	389	-	57.09	12.76	17.84
Dec-14	64	256	424	-	56.35	11.13	10.12
Mar-15	62	245	460	-	58.97	9.65	10.47
Jun-15	63	241	435	-	60.08	11.39	10.60
Sep-15	65	-	377	-	61.31	10.44	9.85
Dec-15	60	242	385	-	56.96	10.48	9.54

Appendix 7.11 : Quarterly production output – Rio Tinto

Source : Rio Tinto (2006 – 2016a)

	Aluminium (kt)	Iron ore (Mt)	Diamonds (Mct)	Copper (kt)	Energy (Mt)
Dec-05	213	31.12	8.90	78.6	36.61
Mar-06	207	28.66	6.32	85.6	37.09
Jun-06	207	33.31	9.20	83.9	39.77
Sep-06	215	35.74	10.07	75.6	38.96
Dec-06	216	35.05	9.56	54.0	40.57
Mar-07	211	32.24	5.03	101.6	37.39
Jun-07	217	37.11	6.41	100.7	36.16
Sep-07	216	36.39	6.77	98.7	37.03
Dec-07	834	38.95	7.80	89.0	39.02
Mar-08	1,025	37.37	3.29	78.3	36.34
Jun-08	1,014	41.86	4.55	82.8	36.48
Sep-08	1,013	42.40	6.11	68.9	40.50
Dec-08	1,011	31.75	6.85	91.6	39.77
Mar-09	948	31.64	5.50	104.3	36.19
Jun-09	942	44.58	1.28	102.0	26.80
Sep-09	956	46.97	2.78	100.6	29.35
Dec-09	957	47.22	4.45	105.5	22.11
Mar-10	937	43.36	3.49	95.9	14.93
Jun-10	952	43.61	3.61	90.6	16.67
Sep-10	939	47.60	3.53	106.7	16.54
Dec-10	962	50.05	3.19	99.5	14.37
Mar-11	944	41.87	2.49	95.2	4.02
Jun-11	958	48.85	2.73	89.9	5.09
Sep-11	962	49.83	3.53	68.3	5.29
Dec-11	961	51.20	2.96	80.9	4.43
Mar-12	854	45.64	3.51	74.1	4.13
Jun-12	841	48.63	2.80	49.3	4.77
Sep-12	855	52.62	3.70	69.7	5.51
Dec-12	906	51.96	3.24	86.2	6.22
Mar-13	834	48.25	3.23	73.0	5.05
Jun-13	901	51.82	4.13	70.4	5.97
Sep-13	878	53.37	4.15	68.3	6.32
Dec-13	853	55.51	4.49	81.0	5.62
Mar-14	832	52.33	3.65	75.8	5.86
Jun-14	817	57.53	3.83	94.6	4.44
Sep-14	848	60.45	3.54	83.5	5.49
Dec-14	842	63.23	2.84	40.7	4.77
Mar-15	809	59.41	4.15	68.2	4.76
Jun-15	818	63.89	4.69	59.9	4.07
Sep-15	830	69.31	4.27	35.8	4.61
Dec-15	864	70,42	4,26	49.2	5.18

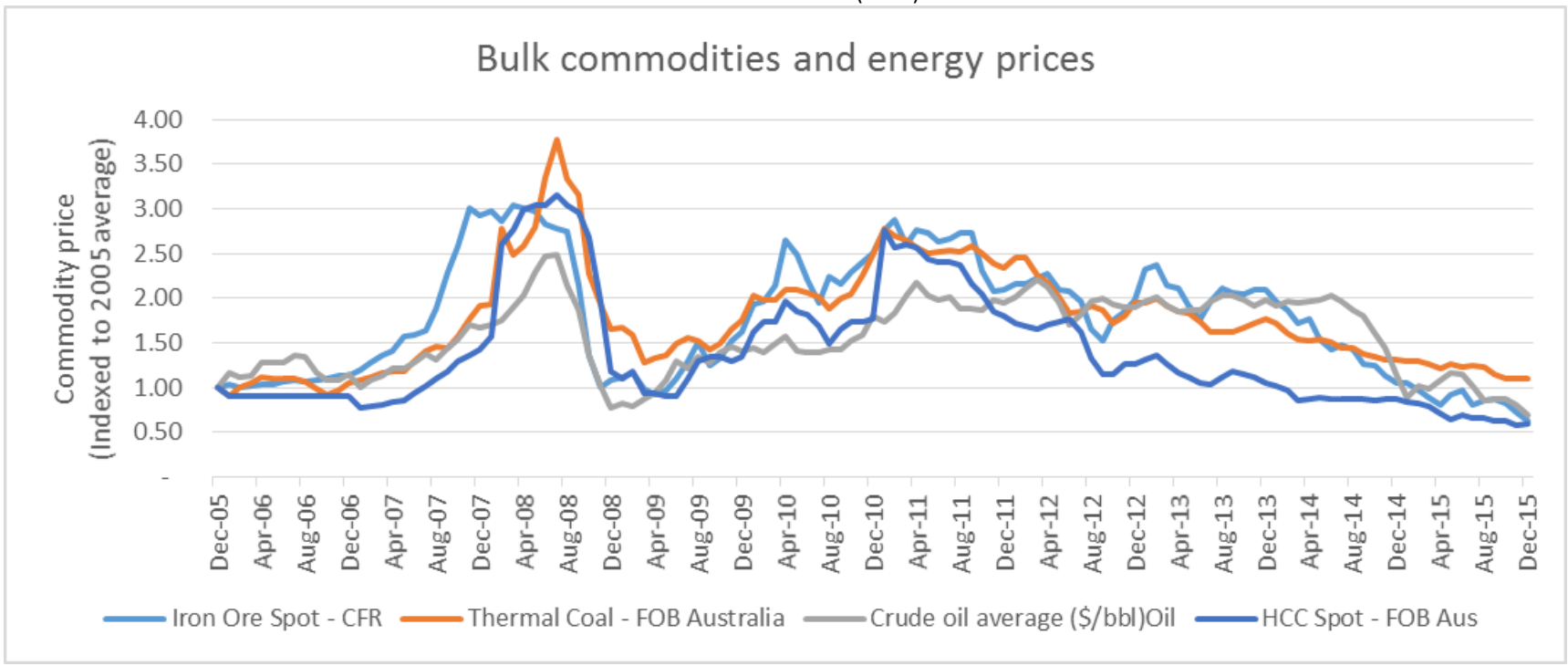
Appendix 7.12 : Quarterly production output – CVRD-Vale

Source : Vale (2006 – 2016)

	Iron Ore (Mt)	Coal (Mt)	Nickel (kt)	Copper (kt)	Fertilizer (Mt)	Bauxite (Mt)
Dec-05	60.56	-	-	22	-	-
Mar-06	65.90	-	-	30	-	-
Jun-06	69.53	-	-	60	-	1.86
Sep-06	68.15	-	69	85	-	1.83
Dec-06	67.35	-	61	78	-	1.73
Mar-07	73.75	0.66	63	68	-	2.12
Jun-07	78.30	1.14	55	65	-	2.58
Sep-07	80.09	0.97	69	74	-	2.66
Dec-07	74.48	0.87	61	73	-	2.46
Mar-08	78.05	1.08	69	77	-	2.42
Jun-08	85.88	1.04	72	80	-	3.19
Sep-08	63.27	1.09	73	82	-	3.54
Dec-08	48.33	0.95	65	73	-	2.98
Mar-09	57.69	1.50	59	61	-	2.85
Jun-09	66.78	1.70	33	31	-	3.30
Sep-09	63.44	1.26	30	32	-	3.31
Dec-09	69.05	1.41	33	34	-	3.26
Mar-10	75.86	1.85	37	40	1.10	3.41
Jun-10	82.61	1.87	44	58	1.40	3.80
Sep-10	80.26	1.74	65	76	1.78	3.85
Dec-10	71.54	1.42	59	70	1.74	-
Mar-11	80.25	1.30	56	63	1.85	-
Jun-11	87.89	0.90	58	84	1.92	-
Sep-11	82.94	2.69	69	85	1.83	-
Dec-11	69.99	1.50	63	73	1.82	-
Mar-12	80.54	1.89	61	70	2.01	-
Jun-12	83.92	1.73	49	68	2.07	-
Sep-12	85.49	1.95	64	81	2.06	-
Dec-12	67.53	1.75	65	90	1.99	-
Mar-13	70.57	2.37	65	91	1.89	-
Jun-13	85.89	2.37	62	95	2.10	-
Sep-13	84.62	2.25	68	95	2.28	-
Dec-13	71.06	1.78	68	88	1.93	-
Mar-14	79.44	2.20	62	81	2.12	-
Jun-14	88.65	2.34	72	105	2.15	-
Sep-14	86.29	2.31	74	105	2.20	-
Dec-14	77.41	1.69	69	107	1.99	-
Mar-15	89.31	2.01	67	105	2.11	-
Jun-15	90.73	2.05	72	99	1.93	-
Sep-15	88.41	1.58	83	113	2.12	-
Dec-15	77.54	1.66	74	112	1.61	-

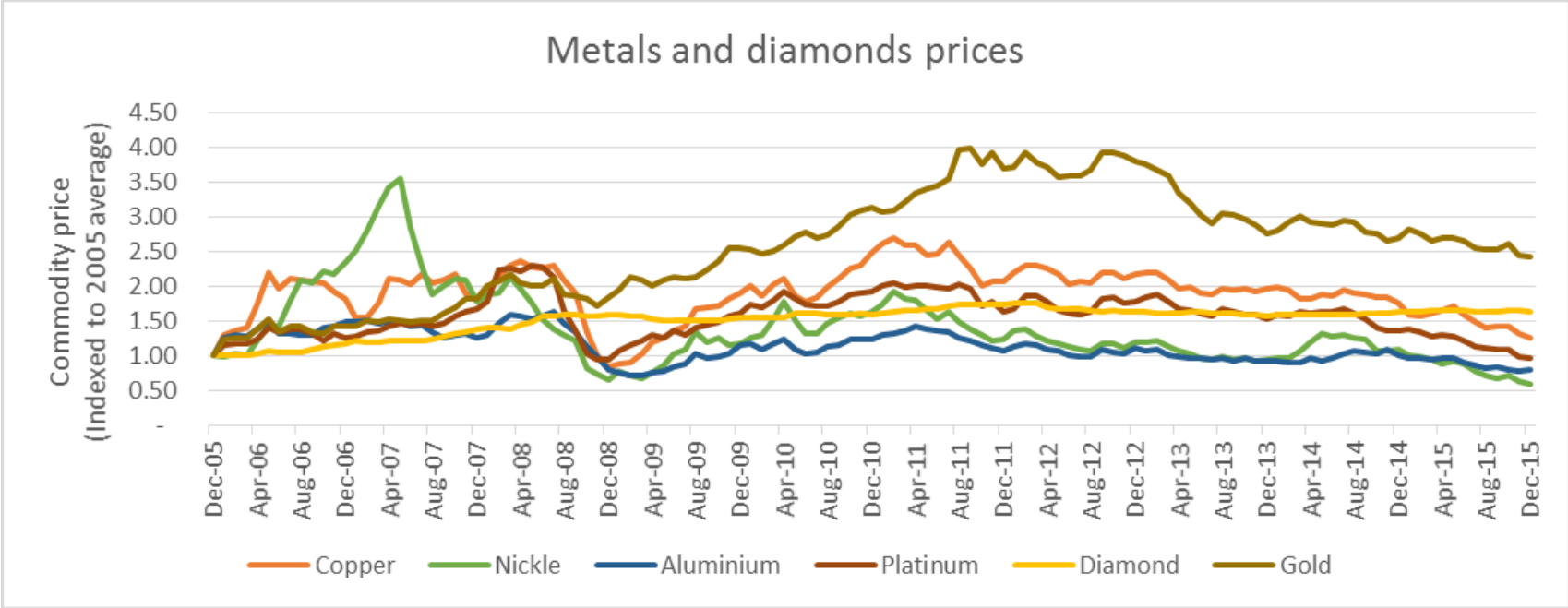
Appendix 7.13 : Bulk commodity and energy prices

Source : World Bank (2016)



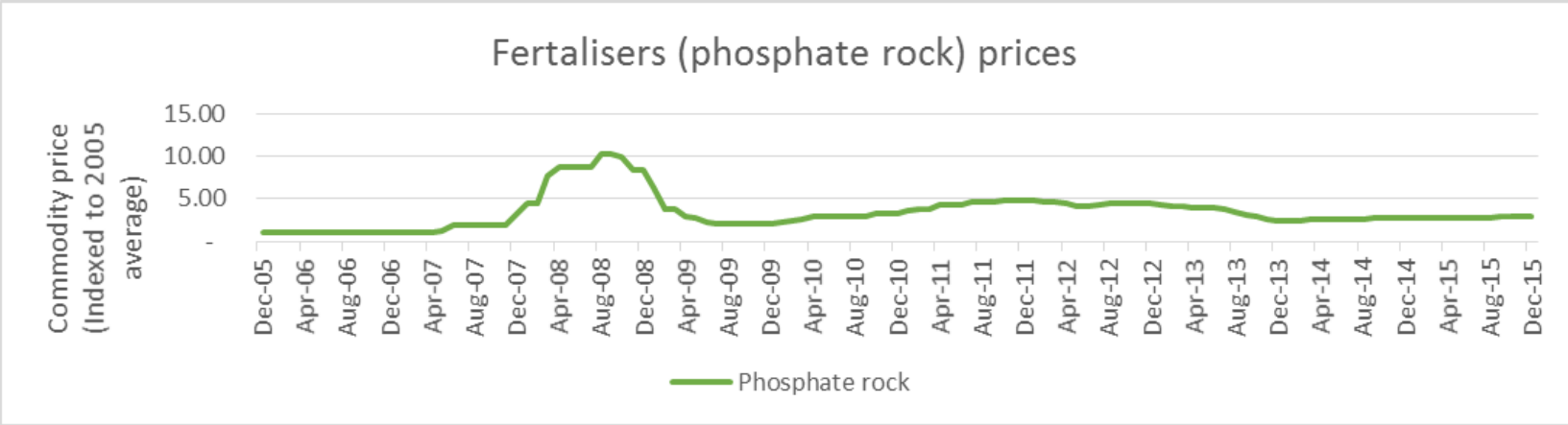
Appendix 7.14 : Metals and diamonds prices

Source : World Bank (2016)



Appendix 7.15 : Fertaliser prices

Source : World Bank (2016)



Appendix 7.16 : Indexed price and commodity calculation – Anglo American

	Copper	Nickel	Iron ore	Coal	Platinum	Diamonds	Gold	Others
Dec-05	8%	2%	6%	10%	11%	10%	8%	47%
Mar-06	10%	2%	6%	15%	14%	10%	5%	44%
Jun-06	15%	3%	6%	17%	16%	10%	6%	44%
Sep-06	16%	4%	6%	17%	17%	11%	6%	44%
Dec-06	15%	5%	6%	15%	16%	12%	6%	44%
Mar-07	11%	6%	7%	17%	15%	12%	4%	38%
Jun-07	17%	7%	9%	21%	15%	13%	4%	38%
Sep-07	17%	4%	11%	24%	15%	13%	0%	38%
Dec-07	16%	4%	18%	27%	19%	13%	0%	38%
Mar-08	16%	3%	18%	35%	19%	13%	0%	32%
Jun-08	18%	3%	19%	50%	22%	15%	0%	32%
Sep-08	15%	2%	19%	58%	16%	16%	0%	32%
Dec-08	9%	1%	8%	33%	14%	13%	0%	32%
Mar-09	7%	1%	8%	22%	8%	1%	0%	26%
Jun-09	10%	2%	7%	23%	15%	7%	0%	26%
Sep-09	13%	2%	12%	26%	15%	9%	0%	26%
Dec-09	16%	2%	13%	26%	16%	12%	0%	26%
Mar-10	15%	2%	18%	30%	18%	8%	0%	19%
Jun-10	14%	3%	20%	33%	19%	10%	0%	19%
Sep-10	14%	3%	18%	34%	19%	11%	0%	19%
Dec-10	17%	2%	21%	38%	21%	11%	0%	19%
Mar-11	17%	4%	20%	38%	20%	9%	0%	14%
Jun-11	17%	3%	23%	40%	20%	11%	0%	14%
Sep-11	18%	4%	24%	42%	23%	6%	0%	14%
Dec-11	16%	4%	20%	41%	17%	9%	0%	14%
Mar-12	17%	5%	18%	35%	3%	4%	0%	13%
Jun-12	16%	5%	20%	34%	17%	4%	0%	13%
Sep-12	16%	3%	16%	32%	18%	8%	0%	13%
Dec-12	18%	3%	12%	31%	13%	10%	0%	13%
Mar-13	17%	2%	17%	29%	18%	8%	0%	8%
Jun-13	16%	2%	16%	30%	17%	10%	0%	8%
Sep-13	19%	3%	14%	29%	17%	10%	0%	8%
Dec-13	20%	3%	17%	28%	14%	11%	0%	8%
Mar-14	18%	3%	15%	24%	10%	9%	0%	9%
Jun-14	17%	4%	13%	13%	10%	11%	0%	9%
Sep-14	16%	5%	13%	13%	14%	10%	0%	9%
Dec-14	15%	2%	11%	23%	14%	11%	0%	9%
Mar-15	13%	2%	9%	20%	12%	10%	0%	6%
Jun-15	14%	2%	8%	11%	12%	10%	0%	6%
Sep-15	12%	2%	9%	11%	12%	8%	0%	6%
Dec-15	11%	2%	7%	16%	10%	9%	0%	6%

Appendix 7.17 : Indexed price and commodity calculation – BHP Billiton

	Petroleum	Aluminium	Base metals	Diamonds	Iron ore	Met. coal	Energy coal	Others
Dec-05	19%	22%	16%	5%	16%	8%	11%	2%
Mar-06	20%	27%	20%	4%	15%	7%	9%	1%
Jun-06	26%	31%	31%	5%	18%	7%	12%	1%
Sep-06	26%	29%	27%	4%	18%	7%	12%	1%
Dec-06	20%	32%	30%	8%	19%	7%	11%	1%
Mar-07	20%	32%	29%	8%	20%	6%	12%	0%
Jun-07	25%	32%	36%	8%	26%	9%	13%	0%
Sep-07	28%	30%	33%	10%	34%	9%	14%	0%
Dec-07	33%	28%	35%	9%	53%	12%	18%	0%
Mar-08	39%	30%	36%	7%	57%	14%	20%	1%
Jun-08	54%	31%	46%	10%	59%	25%	28%	1%
Sep-08	50%	30%	33%	9%	51%	25%	31%	1%
Dec-08	23%	19%	17%	7%	23%	18%	16%	1%
Mar-09	17%	14%	13%	11%	21%	7%	12%	3%
Jun-09	28%	16%	20%	10%	18%	8%	13%	3%
Sep-09	35%	20%	23%	9%	27%	11%	14%	3%
Dec-09	36%	22%	25%	9%	33%	11%	13%	3%
Mar-10	36%	23%	23%	9%	42%	12%	17%	1%
Jun-10	40%	22%	28%	9%	52%	18%	17%	1%
Sep-10	40%	23%	29%	8%	46%	15%	17%	1%
Dec-10	40%	25%	36%	8%	54%	12%	19%	1%
Mar-11	44%	26%	37%	7%	62%	16%	9%	0%
Jun-11	59%	28%	35%	7%	65%	18%	24%	0%
Sep-11	66%	26%	27%	6%	72%	19%	24%	0%
Dec-11	74%	23%	29%	6%	60%	15%	21%	0%
Mar-12	79%	21%	32%	6%	56%	11%	21%	0%
Jun-12	72%	17%	34%	5%	59%	13%	19%	0%
Sep-12	78%	18%	29%	4%	46%	11%	19%	0%
Dec-12	76%	20%	32%	4%	53%	10%	17%	0%
Mar-13	72%	21%	48%	4%	62%	11%	16%	1%
Jun-13	73%	20%	46%	0%	62%	11%	17%	1%
Sep-13	83%	19%	40%	0%	67%	10%	16%	1%
Dec-13	75%	18%	44%	0%	68%	11%	16%	1%
Mar-14	78%	17%	40%	0%	62%	10%	15%	0%
Jun-14	85%	17%	44%	0%	60%	9%	14%	0%
Sep-14	84%	18%	38%	0%	54%	10%	13%	0%
Dec-14	59%	17%	39%	0%	43%	9%	7%	0%
Mar-15	39%	15%	37%	0%	39%	7%	7%	2%
Jun-15	47%	15%	37%	0%	36%	7%	7%	2%
Sep-15	39%	0%	28%	0%	35%	6%	6%	2%
Dec-15	31%	12%	26%	0%	28%	6%	5%	2%

Appendix 7.18 : Indexed price and commodity calculation – Rio Tinto

	Aluminium	Iron Ore	Diamonds	Copper	Energy	Others
Dec-05	13%	27%	17%	23%	19%	1%
Mar-06	16%	25%	12%	34%	19%	1%
Jun-06	18%	30%	18%	49%	22%	1%
Sep-06	17%	33%	20%	47%	21%	1%
Dec-06	19%	33%	21%	31%	20%	1%
Mar-07	19%	35%	12%	49%	21%	0%
Jun-07	20%	48%	15%	62%	22%	0%
Sep-07	18%	60%	16%	61%	27%	0%
Dec-07	67%	94%	20%	52%	35%	0%
Mar-08	92%	94%	9%	49%	44%	1%
Jun-08	97%	105%	13%	56%	54%	1%
Sep-08	92%	92%	19%	43%	71%	1%
Dec-08	60%	31%	21%	29%	40%	1%
Mar-09	42%	29%	17%	29%	28%	13%
Jun-09	46%	38%	4%	38%	19%	13%
Sep-09	57%	54%	8%	48%	22%	13%
Dec-09	63%	60%	13%	57%	18%	13%
Mar-10	66%	74%	10%	56%	15%	8%
Jun-10	65%	91%	11%	51%	18%	8%
Sep-10	64%	86%	11%	62%	17%	8%
Dec-10	74%	102%	10%	69%	17%	8%
Mar-11	77%	98%	8%	74%	6%	8%
Jun-11	82%	112%	9%	67%	7%	8%
Sep-11	75%	115%	12%	49%	7%	8%
Dec-11	66%	94%	10%	49%	5%	8%
Mar-12	61%	85%	12%	50%	5%	8%
Jun-12	54%	89%	9%	31%	5%	8%
Sep-12	54%	77%	12%	43%	5%	8%
Dec-12	59%	82%	10%	55%	6%	8%
Mar-13	54%	94%	10%	47%	5%	1%
Jun-13	54%	85%	13%	41%	6%	1%
Sep-13	51%	93%	13%	39%	5%	1%
Dec-13	49%	98%	14%	47%	5%	1%
Mar-14	46%	83%	11%	43%	5%	0%
Jun-14	48%	77%	12%	52%	3%	0%
Sep-14	55%	72%	11%	47%	4%	0%
Dec-14	54%	62%	9%	22%	3%	0%
Mar-15	48%	49%	13%	32%	3%	0%
Jun-15	47%	49%	15%	29%	3%	0%
Sep-15	43%	50%	13%	15%	3%	0%
Dec-15	42%	43%	13%	19%	3%	0%

Appendix 7.19 : Indexed price and commodity calculation – CVRD-Vale

	Iron ore	Coal	Nickel	Copper	Fertilizer	Bauxite	Others
Dec-05	29%	0%	0%	3%	0%	11%	9%
Mar-06	32%	0%	0%	1%	0%	11%	7%
Jun-06	35%	0%	0%	3%	0%	11%	7%
Sep-06	35%	0%	27%	4%	0%	7%	7%
Dec-06	36%	0%	27%	4%	0%	5%	7%
Mar-07	45%	0%	34%	3%	0%	4%	5%
Jun-07	57%	1%	35%	3%	0%	5%	5%
Sep-07	74%	1%	28%	4%	0%	5%	5%
Dec-07	102%	1%	24%	3%	0%	4%	5%
Mar-08	111%	1%	27%	4%	0%	5%	5%
Jun-08	121%	1%	25%	4%	0%	7%	5%
Sep-08	78%	2%	18%	4%	0%	7%	5%
Dec-08	27%	1%	9%	2%	0%	4%	5%
Mar-09	30%	1%	8%	1%	0%	3%	6%
Jun-09	32%	1%	6%	1%	0%	4%	6%
Sep-09	41%	1%	7%	1%	0%	4%	6%
Dec-09	50%	1%	8%	1%	0%	5%	6%
Mar-10	74%	2%	10%	2%	4%	5%	4%
Jun-10	97%	2%	13%	3%	6%	6%	4%
Sep-10	82%	2%	18%	4%	8%	6%	4%
Dec-10	83%	1%	18%	4%	8%	0%	4%
Mar-11	106%	2%	20%	4%	10%	0%	4%
Jun-11	114%	1%	19%	5%	12%	0%	4%
Sep-11	108%	3%	20%	5%	12%	0%	4%
Dec-11	73%	2%	15%	4%	12%	0%	4%
Mar-12	84%	2%	16%	4%	13%	0%	5%
Jun-12	87%	2%	11%	4%	13%	0%	5%
Sep-12	71%	2%	14%	4%	13%	0%	5%
Dec-12	60%	2%	15%	5%	12%	0%	5%
Mar-13	77%	2%	15%	5%	11%	0%	2%
Jun-13	80%	2%	12%	4%	12%	0%	2%
Sep-13	83%	2%	13%	4%	11%	0%	2%
Dec-13	71%	2%	12%	4%	7%	0%	2%
Mar-14	71%	2%	12%	4%	7%	0%	3%
Jun-14	67%	2%	18%	5%	8%	0%	3%
Sep-14	58%	2%	18%	5%	8%	0%	3%
Dec-14	43%	1%	15%	5%	8%	0%	3%
Mar-15	42%	1%	13%	4%	8%	0%	1%
Jun-15	39%	1%	12%	4%	7%	0%	1%
Sep-15	36%	1%	12%	4%	8%	0%	1%
Dec-15	27%	1%	9%	4%	7%	0%	1%

Appendix 7.20 : Indexed semi-annual value drivers data – Anglo American

Source : Anglo American (2006 – 2016)

	Enterprise value	Gearing	EBITDA margin	Theoretical revenue
Dec-05	1.0	1.0	1.0	1.0
Jun-06	1.1	0.6	1.1	1.2
Dec-06	1.3	0.6	2.2	1.2
Jun-07	1.6	1.2	1.2	1.2
Dec-07	1.7	1.0	1.9	1.4
Jun-08	1.8	1.0	1.4	1.6
Dec-08	0.8	2.0	1.2	1.1
Jun-09	0.9	1.9	1.0	0.9
Dec-09	1.3	1.7	1.1	1.1
Jun-10	1.1	1.6	1.3	1.2
Dec-10	1.4	1.0	1.3	1.3
Jun-11	1.4	0.2	1.4	1.3
Dec-11	1.0	0.2	1.3	1.2
Jun-12	0.9	0.4	1.1	1.1
Dec-12	1.0	1.0	0.7	1.0
Jun-13	0.7	1.2	1.0	1.0
Dec-13	0.8	1.3	1.0	1.0
Jun-14	0.8	1.4	1.0	0.8
Dec-14	0.7	1.7	0.7	0.8
Jun-15	0.6	1.9	0.9	0.6
Dec-15	0.4	2.2	0.4	0.6

Appendix 7.21 : Indexed annual value drivers data – Anglo American

Source : Anglo American (2006 – 2016)

	EV	ROCE	Net debt to EBIDTA	EBITDA multiple
Dec-05	1.0	1.0	1.0	1.0
Dec-06	1.3	1.3	0.5	1.0
Dec-07	1.7	2.0	0.8	1.2
Dec-08	0.8	1.9	1.7	0.6
Dec-09	1.3	0.8	2.9	1.7
Dec-10	1.4	1.3	1.1	1.1
Dec-11	1.0	1.4	0.2	0.6
Dec-12	1.0	0.7	1.9	1.1
Dec-13	0.8	0.6	2.2	0.8
Dec-14	0.7	0.5	3.3	0.9
Dec-15	0.4	0.3	5.2	0.7

Appendix 7.22 : Indexed semi-annual value drivers data – BHP Billiton

Source : BHP Billiton (2005 – 2015) & South 32 (2015)

	Enterprise Value	Gearing	EBITDA Margin	Theoretical Revenue
Dec-05	1.0	1.0	1.0	1.0
Jun-06	1.2	1.1	1.8	1.3
Dec-06	1.1	0.8	1.1	1.3
Jun-07	1.6	1.0	1.0	1.5
Dec-07	2.0	1.1	1.0	1.9
Jun-08	2.2	0.7	1.1	2.5
Dec-08	1.1	0.4	1.1	1.2
Jun-09	1.5	0.5	0.5	1.1
Dec-09	2.1	0.6	1.0	1.5
Jun-10	1.6	0.3	1.1	1.9
Dec-10	2.3	0.2	1.1	2.0
Jun-11	2.3	0.4	1.5	2.4
Dec-11	2.0	1.0	1.1	2.3
Jun-12	1.9	1.0	1.5	2.2
Dec-12	2.3	1.2	0.9	2.1
Jun-13	1.8	1.1	1.0	2.3
Dec-13	2.1	1.3	1.1	2.3
Jun-14	2.0	0.9	0.9	2.3
Dec-14	1.5	0.9	1.1	1.8
Jun-15	1.6	1.0	1.5	1.6
Dec-15	1.1	1.0	0.7	1.2

Appendix 7.23 : Indexed annual value drivers data – BHP Billiton

Source : BHP Billiton (2005 – 2015) & South 32 (2015)

	EV	ROCE	Net debt to EBIDTA	EBITDA margin	EBITDA multiple
Jun-06	1.0	1.0	1.0	1.0	1.0
Jun-07	1.4	1.0	1.4	0.7	1.6
Jun-08	1.8	1.0	0.9	0.7	1.7
Jun-09	1.2	0.7	0.9	0.6	1.7
Jun-10	1.4	0.7	0.4	0.7	1.4
Jun-11	1.9	1.2	0.5	0.9	1.5
Jun-12	1.6	0.4	2.3	0.9	1.3
Jun-13	1.5	0.6	3.2	0.7	1.4
Jun-14	1.7	0.4	2.6	0.7	1.4
Jun-15	1.3	0.1	2.6	0.9	1.1

Appendix 7.24 : Indexed semi-annual value drivers data – Rio Tinto

Source : Rio Tinto (2006 – 2016a)

	Enterprise value	Gearing	Theoretical revenue
Dec-05	1.0	1.0	1.0
Jun-06	1.1	1.8	1.4
Dec-06	1.1	1.5	1.3
Jun-07	1.6	1.5	1.7
Dec-07	2.9	8.2	2.7
Jun-08	3.1	7.2	3.3
Dec-08	1.2	8.2	1.8
Jun-09	1.7	8.7	1.6
Dec-09	2.1	3.8	2.2
Jun-10	1.8	2.6	2.4
Dec-10	2.6	0.8	2.8
Jun-11	2.8	1.4	2.8
Dec-11	1.9	1.6	2.3
Jun-12	2.0	3.0	2.0
Dec-12	2.3	3.2	2.2
Jun-13	1.8	3.7	2.0
Dec-13	2.2	3.3	2.1
Jun-14	2.0	2.4	1.9
Dec-14	1.8	2.4	1.5
Jun-15	1.6	2.8	1.4
Dec-15	1.3	3.1	1.2

Appendix 7.25 : Indexed annual value drivers data – Rio Tinto

Source : Rio Tinto (2006 – 2016a)

	EV	ROCE	Net debt to EBIDTA	EBITDA margin	EBITDA multiple
Dec-05	1.0	1.0	1.0	1.0	1.0
Dec-06	1.1	1.2	1.4	1.1	0.9
Dec-07	2.9	0.4	24.6	0.9	2.1
Dec-08	1.2	0.5	12.0	0.9	0.5
Dec-09	2.1	0.3	9.8	0.7	1.5
Dec-10	2.6	0.7	1.2	1.0	1.0
Dec-11	1.9	0.4	2.2	0.9	0.6
Dec-12	2.3	(0.1)	7.1	0.8	1.1
Dec-13	2.2	0.3	6.4	0.8	1.0
Dec-14	1.8	0.4	4.9	0.8	0.9
Dec-15	1.3	0.2	8.5	0.7	1.0

Appendix 7.26 : Indexed semi-annual value drivers data – CVRD-Vale

Source : Vale (2006 - 2016)

	Enterprise value	Gearing	Theoretical revenue
Dec-05	-	-	-
Jun-06	1.0	1.0	1.0
Dec-06	1.3	2.6	1.4
Jun-07	1.9	2.0	1.9
Dec-07	1.5	1.9	2.5
Jun-08	1.6	1.6	2.9
Dec-08	0.6	0.8	0.9
Jun-09	0.9	1.0	0.9
Dec-09	1.4	1.1	1.3
Jun-10	1.2	1.1	2.3
Dec-10	1.6	1.0	2.1
Jun-11	1.5	0.6	2.8
Dec-11	1.1	1.1	2.0
Jun-12	1.0	1.1	2.2
Dec-12	1.1	1.3	1.8
Jun-13	0.8	1.3	2.0
Dec-13	0.9	1.5	1.8
Jun-14	0.8	1.4	1.8
Dec-14	0.6	1.7	1.3
Jun-15	0.5	1.9	1.2
Dec-15	0.4	2.2	0.9

Appendix 7.27 : Indexed annual value drivers data – CVRD-Vale

Source : Vale (2006 - 2016)

	EV	ROCE	Net debt to EBIDTA	EBITDA margin	EBITDA multiple
Dec-05	-	-	-	-	-
Dec-06	1.0	1.0	1.0	1.0	1.0
Dec-07	1.1	1.4	0.6	1.1	0.6
Dec-08	0.4	1.4	0.2	1.5	0.2
Dec-09	1.1	0.5	0.9	0.9	1.1
Dec-10	1.2	1.4	0.3	1.2	0.4
Dec-11	0.8	1.8	0.3	1.3	0.2
Dec-12	0.8	0.5	0.7	0.8	0.4
Dec-13	0.6	0.9	0.5	1.1	0.3
Dec-14	0.4	0.5	0.9	0.8	0.3
Dec-15	0.3	(0.6)	1.8	0.6	0.3