Analysis of capital allocation by mining companies

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DECLARATION

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ABSTRACT

Mining operations are by nature capital intensive. Historically mining companies have in general been poor at capital allocation decision making, which translated in poor returns on capital invested and impairments. Better capital allocation strategies are required for mining companies to unlock more value from invested capital.

This research focussed on identifying factors to consider during the capital allocation decision-making process that can potentially unlock value in mineral projects. The research included a review of capital allocation decisions and performance of five mining companies from 2001 to 2017. This period covers one full commodity price cycle to determine the impact of the prevailing commodity price on capital allocation decisions. Through analysis of the historical capital allocation of the five mining companies the research aimed to test if it is possible to unlock value by allocating capital in a counter cyclical approach compared to the prevailing commodity prices.

From the analysis of the historical capital allocation decisions made by five mining companies a number of common trends were identified. The research found that during a period of higher commodity prices, mining companies focussed primarily on volume growth. This is confirmed by a strong correlation between the value of capital approvals and the average commodity prices of the basket of minerals produced. The higher allocation of capital towards growth initiatives, such as expansionary capital and acquisitions, have in a number of instances resulted in significant capital over-expenditures in projects. The over-expenditures have directly contributed to a number of impairment charges made by the diversified mining companies during a declining commodity price cycle.

Conversely, during periods of declining commodity prices mining companies focused on rationalisation of mining projects and operations and disposal of assets that do not meet minimum investment criteria. During these periods capital allocation towards growth projects were reduced, with most capital allocated to reduction of net debt on the balance sheet. The research found a common trend of higher capital allocation towards growth projects during historical high commodity prices, and during subsequent lower commodity prices capital allocation was directed towards reduction of net debt and disposal of loss making assets.

Results from the research conducted on the five mining companies indicated that there may be correlation between return on investment and the timing of the capital investment in relation to the position on the commodity price cycle at the time of the investment. However, the results obtained for the five mining companies were influenced by operational returns from existing operations, which makes it difficult to determine returns realised on incremental capital expenditures.

From the results obtained from the analysis the following recommendations are made for a capital allocation strategy to increase the probability of unlocking value over the long term. Firstly, a company should have a clear capital allocation framework that is guided by the mining company's strategic objectives. The framework should clearly indicate the hierarchy of importance when allocating capital to different areas. Secondly the company should clearly identify the minimum investment criteria to be met before capital is allocated to an investment. Lastly the mining company should aim to consistently invest capital throughout the commodity price cycle, and be cautious of over allocating capital towards growth projects during periods of high commodity prices.

ACKNOWLEDGEMENTS

This research has been very valuable to me to witness the progressive change in capital allocation strategy of the major mining companies over a 17 year period through various commodity cycles. I've also developed a better understanding of the key metrics and financial ratios in company annual financial statements which are important barometers in understanding a company's capital allocation strategy. I acknowledge the contributions and give my appreciation to the following individuals:

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BMA	Billiton Mitsubishi Alliance
BCPI	Basket commodity price index weighted by each commodity’s contribution to sales
CAGR	Compounded annual growth rate
CARs	Cumulative abnormal returns
CEO	Chief executive officer
CI	Capital invested
CIPCI	Capital Invested Price Cycle Index
CIV	Customer influence value
CKV	Customer knowledge value
CLV	Customer lifetime value
CROIC	Cash return on invested capital
CRV	Customer referral value
CVRD	Companhia Vale do Rio Doce
DCF	Discounted cash flow
DRC	Democratic Republic of the Congo
EBIT	Earnings before interest and tax
EBITDA	Earnings before interest, tax, depreciation and amortisation
FCF	Free cash flow
GFC	Global financial crisis
IAS 36	International Accounting Standards Number 36
IPO	Initial public offering
JV	Joint venture
LNG	Liquefied natural gas
LHS	Left-hand side
M&A	Mergers and acquisitions

MAP	Molybdenum Autoclave Process
mtpa	Million tonnes per annum
NOPAT	Net operating profit after tax
OCF	Operating cash flow
PGM's	Platinum group metals
PPA	Predictive project analytics
PVI	Production volume index
R^2	Coefficient of determination
R&D	Research and development
RGP4	Rapid Growth Project Four
RGP5	Rapid Growth Project Five
RHS	Right-hand side
ROACE	Return on average capital employed
ROCE	Return on capital employed
RODCF	Real option discounted cash flow
ROIC	Return on invested capital
S&P GSCI	Standard and Poor GSCI commodity index
SP500	Standard and Poor 500
SPGMI	Standard and Poor Global Mining Index
SIB	Stay-in-business
USA	United States of America
USA CPI	United States of America consumer price index
WACC	Weighted average cost of capital

1 INTRODUCTION

1.1 Chapter overview

An introduction to capital allocation by mining companies and a background to the economic performance of mining companies in relation to companies from other sectors is provided in this chapter. The importance of capital allocation to mining companies and other stakeholders is discussed. The research problem and research question are presented and discussed. The selection criteria for the companies that were analysed are listed and lastly brief historical backgrounds of the companies that were selected for analysis are provided.

1.2 Research background

The 10 year period from 2006 to 2016 has witnessed significant volatility in commodity prices relative to the previous 40 years. A good indicator of the global commodity prices is the Standard and Poor GSCI commodity index (S&P GSCI) which tracks the commodity pricing of a basket of 24 commodities from all commodity sectors (Goldman Sachs, 2016). The historical prices of the S&P GSCI from 1970 to 2016 is provided in Figure 1.1. Figure 1.1 shows that there was significant commodity price volatility during the last 11 years (2006 – 2017), during which the index rose from a level of 6 260 in November 2006 to an all-time high of 10 898 in July 2008 (74% improvement), and then dropped to a value of 2 200 on 18 November 2016. This is a variance of 79.8% over the 10 year period, with S&P GSCI levels in November 2016 at similar to levels last witnessed in the early 1990's.

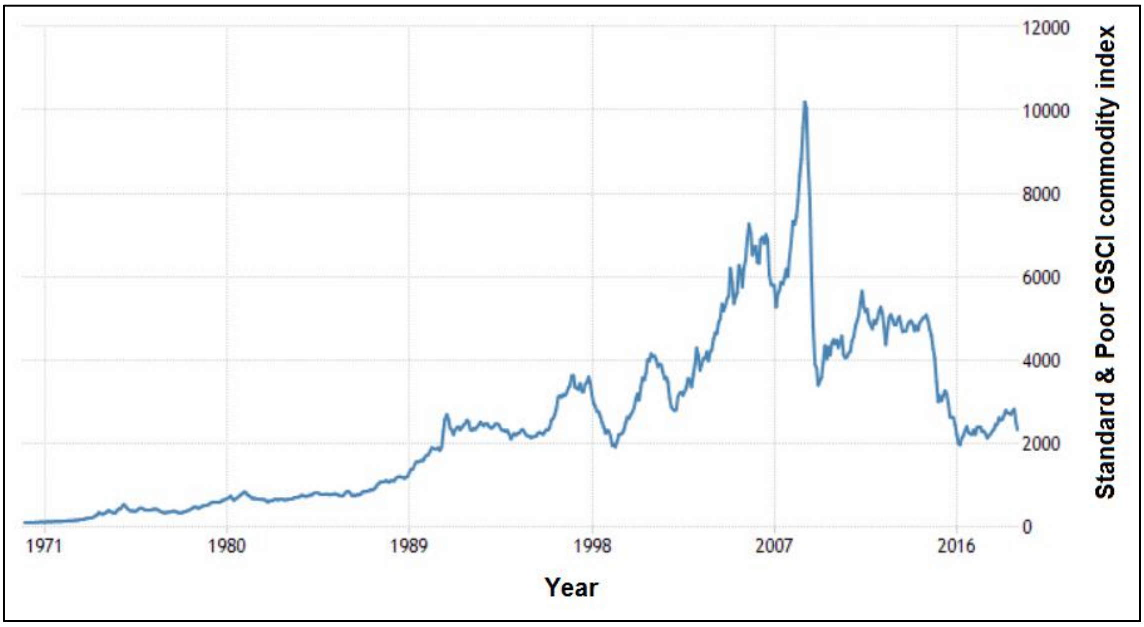

Figure 1.1: Standard and Poor GSCI Commodity Index
(Source: Trading Economics, 2018)

The prices that mining companies obtain for the selling of their products is one of the most important factors in determining the profitability of the companies. It is therefore of no surprise that the extreme volatility in commodity prices witnessed over the last 10 years had a significant impact on valuation and market capitalisation of mining companies as demonstrated in Figure 1.2. Figure 1.2 compares the worldwide commodity prices in the form of the S&P GSCI to the worldwide market capitalisation of mining companies in the form of the Standard and Poor Global Mining Index (SPGMI).

Figure 1.2: Standard and Poor GSCI commodity index compared to the Standard and Poor Global Mining Index

(Source: Trading Economics, 2018)

Figure 1.2 shows a close correlation between the basket of worldwide commodity prices and the worldwide mining company market capitalisation performance over the last 10 years until 2016. From 2016 there was no correlation which could be ascribed to better financial performance by the mining companies in a low commodity price environment.

When comparing the SPGMI with a general stock index such as the Standard and Poor 500 (SP500), which tracks the largest 500 companies listed on the New York Stock Exchange by market capitalisation, it can be seen that mining companies have underperformed other industry sectors from 2012 to 2016. The relative performance of the SP500 index compared to the SPGMI over the last 10 years is shown in Figure 1.3.

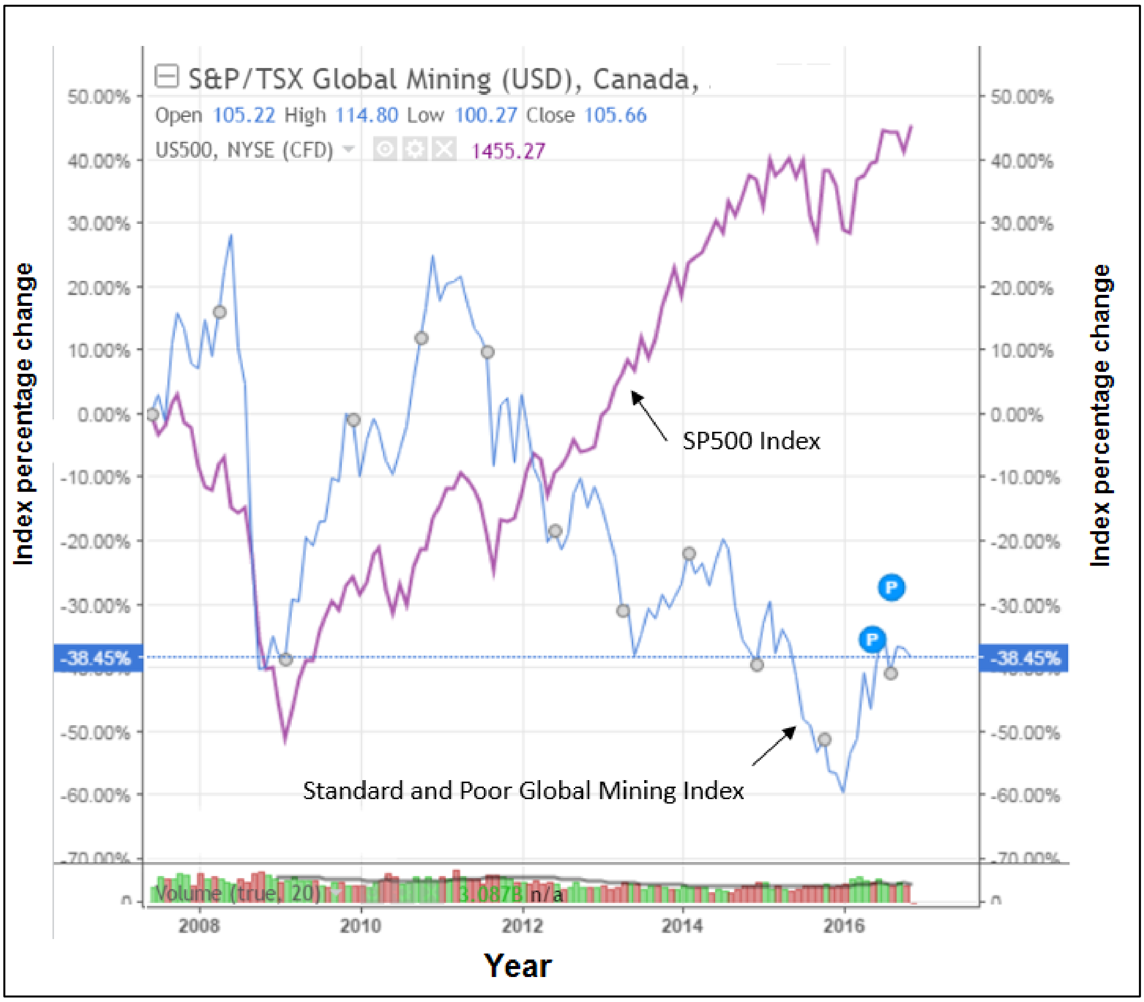

Figure 1.3: SP500 index compared to the SPGMI
(Source: Trading Economics, 2018)

Figure 1.3 indicates that in general the mining sector has underperformed relative to other large industrial sectors from 2012 onwards. A large portion of the underperformance can be attributed to the drop in commodity prices over the period as demonstrated by the correlation between commodity prices and mining company market capitalisation performance shown in Figure 1.2. However, does this mean that the valuation of mining companies is only driven by commodity price or are there are factors that drive value?

It has been theorised that capital allocation decisions is one of the key determinants of the success of a company over the long term (Mauboussin and Callahan, 2014a). This is especially true for natural resources companies including mining companies that are by nature capital intensive. Mining companies are also price takers and therefore subject to the commodity pricing cycle which have a dramatic influence on the success of a project depending on the timing of a capital allocation decision.

Duval (2014) argued that a large portion of the underperformance of mining companies can be attributed to poor allocation of capital, and that better capital allocation by a company can unlock value relative to other mining companies. He further stated that during the large upswing in commodity prices witnessed between 2005 and 2008, and subsequently again during 2009 to 2012, poor capital allocation decisions were made by mining companies to achieve growth for the sake of growth. Most mining companies were driven by growth aspirations which were fuelled by the long upward trajectory of commodity prices, brought about by the high economic growth rates achieved in China and its seemingly insatiable demand for commodities (Duval, 2014).

According to PwC (2008), during the height of the commodity price cycle between 2006 and 2008 mining companies' growth were obtained through either acquisitions, mergers or increased number of green and brownfield projects. The combination of high commodity prices, relatively easy access to capital, and increased competition amongst mining companies for a seemingly smaller pool of quality Mineral Resource assets, drove valuations to historic highs. This led to capital allocation decisions by mining companies which subsequently proved to be value destructive. The ensuing reduction of global and Chinese economic growth rates combined with the oversupply of commodities brought about by the dramatic increase in growth projects, have led to a noteworthy weakening of commodity prices during 2013 to 2016, as demonstrated in Figure 1.1. This in turn led to a major drop in mining company valuations which brought about an unprecedented amount of impairments peaking at US$57 billion announced in 2013 by the top 40 mining companies by market capitalisation (PwC, 2013). The poor capital allocation decisions made during the commodity up cycle were exposed to a large degree.

1.3 Problem statement and research question

Mining operations are by nature capital intensive. Historically, mining companies in general have been poor at making capital allocation decisions (Duval, 2014). The consequences of poor capital allocation decisions can be summarised as follow:

- Poor financial returns on capital invested;
- Significant capital write-downs;
- Underperformance in the share price of mining companies relative to companies in other industries; and
- Destruction of value.

Given these consequences the following question arise:

"*How can mining companies unlock value through better capital allocation decisions?*"

1.4 Research hypothesis

The timing of a capital allocation decision can potentially have a major impact on the investment return that a mining company realises. Due to external factors, many mining companies invest in either greenfields or brownfield growth projects, or mergers and acquisitions (M&A) during the top half of a commodity price cycle which is typically 10 to 15 years in duration. This however has often proved to be the incorrect time of the commodity pricing cycle to invest in growth projects for the following reasons:

- According to PwC (2007), during the top half of the commodity price cycle mining companies' values tend to be higher than average due to the higher expectation of commodity prices increase. This may lead to higher than average acquisition or merger costs. An example of this is the Minas Rio acquisition made by Anglo American at the top of the iron ore commodity price cycle.
- During the top half of the commodity price cycle many mining projects are approved, leading to potential project skills shortages (PwC, 2008). A lack of project estimating and implementation skills may result in longer execution times, and increased project costs relative to the approved project estimate due to mistakes made during the project estimation and implementation phase.
- Greenfield mining project lead times from discovery to first production are typically very long with durations of a few years up to decades after the initial resource discovery (World Bank, 2016). Given that a commodity price cycle is typically 10 to 15 years in duration, this means that a project approved during the top half of the cycle will likely reach full production during the bottom or close to the bottom of the commodity price cycle. The lower sales prices often have a drastic effect on the profitability of the new mining operation just as full production is obtained and capital repayment requirements are at their greatest. In worst case scenarios the project does not reach full production in time due to unforeseen technical

constraints. This delayed production ramp-up combined with higher production unit costs due to lower mining volumes, and lower commodity prices have a drastic negative effect on the ability of the project to generate free-cash flow.

Based on the reasons above it has been hypothesised that capital allocation that unlock the most value is typically done counter cyclical, when commodity prices are at historical low values, in order to capitalise on the upward trajectory of the commodity cycle, as production ramp-up is achieved. Therefore, the research hypothesis is that value can be unlocked through allocating capital on a counter cyclical manner relative to the historical commodity price cycle.

1.5 Research aim and objectives

The aim of the research is to identify factors that mining companies should consider during the capital allocation decision-making process that can unlock value in mineral projects. The objectives of this research study are to:

- Review literature on accepted mining valuation approaches;
- Review capital allocation of a select few large diversified mining companies as a function of the commodity price cycle;
- Test the hypothesis that companies that allocate capital using a counter commodity cycle philosophy are generally more successful and rewarded by the market; and
- Recommend a capital allocation strategy that will increase the probability of unlocking value over the long term.

1.6 Research significance

Through gaining a better understanding of the capital allocation decision making of mining companies, insight may be gained of the common mistakes that mining companies have made in past capital allocation decisions. This insight may assist mining companies' executives and other key stakeholders from repeating the same mistakes made in the past in relation to capital allocation decisions. This will ultimately ensure optimal value creation from mining projects.

1.7 Research scope

The research study utilised the framework provided by Mauboussin and Callahan (2014a) to analyse the historical capital allocation of a few selected large diversified mining companies from 2001 to 2017. The period from 2001 to 2017 was selected as it is representative of one full commodity price cycle. Therefore, this period provides an opportunity to review mining companies' capital allocation decisions throughout the cycle and determines if there is a correlation between the commodity price cycle and the capital allocation decisions that were made during that period.

Four large diversified mining companies and one single commodity focussed growth mining company were selected for analysis in this study. The companies were selected based on the following selection criteria:

- Historical financial statements need be available in the public domain for the full period of analysis;
- Companies need to have a diversified commodity production portfolio to be considered representative of the mining industry. The one exception to this requirement is First Quantum which was included due exceptional growth in shareholder equity achieved over the last 17 years;
- Companies preferably must have announced substantial capital write-downs during the period under review. This provides the opportunity to evaluate the major factors that contributed to the underperformance of the capital investment compared to original expectations; and
- One growth orientated mining company that allocated capital towards growth projects throughout the commodity price cycle, was also selected

as an outliner to ensure that the full spectrum of capital allocation strategies were covered in the study.

Based on these criteria the four large diversified companies that were selected for analysis in the research study are; Anglo American, BHP, Rio Tinto, and Vale S.A. (Vale). According to PwC (2008), these four companies had the highest market capitalisation in the mining sector during the peak of the commodity price cycle in 2008. In addition to the four, First Quantum was selected as an outliner to represent a growth company that has allocated capital towards growth projects throughout the commodity price cycle. A brief historical overview of the mining companies are provided in the next sub-sections.

1.7.1 Anglo American

Anglo American is a multi-national diversified mining company that produces a range of commodities which include copper, platinum, diamonds, iron ore, manganese, coal and nickel (Anglo American, 2017). Anglo American have a number of operations in Southern Africa, North America, South America and Australasia. The company's headquarters is based in London and the company is listed on the London Stock Exchange and the Johannesburg Stock Exchange.

Katzenellenbogen (2006) provides a comprehensive history of the company. Anglo American was founded in South Africa in 1917 by Sir Ernest Oppenheimer. Initially the company focussed on gold mining in the East Rand in South Africa. It soon started expanding into other commodities and in 1926 became the single largest shareholder of the De Beers Group. In December 1928 Anglo American expanded into the Northern Rhodesia, now Zambian Copperbelt, through the creation of Rhodesian Anglo American Limited. During the 1940's and 1950's Anglo American's primary focus was on the consolidation and expansion of gold mining in the Orange Free State, South Africa. The focus on gold mining enabled Anglo American to become the world's largest gold producer by 1960. In 1961 Anglo American made its first investment outside of Southern Africa through the acquisition of Hudson Bay Mining and Smelting Company in Canada. In the 1960's and 70's the company further diversified its production portfolio through investments in the steel industry and paper industry. In 1999 Anglo American merged with Minorco to form Anglo American plc with a primarily listing on the London Stock Exchange and a secondary listing on the Johannesburg Security Exchange.

During the period of heightened commodity prices between 2004 and 2008 Anglo American's focus was mainly on volume growth. This was achieved through a combination of new projects and acquisitions of existing mines or mineral projects. Out of all the acquisitions, the Minas Rio operation was Anglo American's largest investment with a more than US$13 billion investment (Anglo American, 2013). Due to a combination of project delays, project cost overruns and decrease in iron ore prices, the investment did not deliver the anticipated returns which led to a cumulative capital impairment of US$10.4million on Minas Rio over the period from 2013 to 2015 (Anglo American, 2015).

During the period from 2012 to 2016 the strategic objectives of Anglo American has markedly changed from the growth orientated objectives during the commodity boom period from 2004 to 2008, and subsequent 2009 to 2012. The focus during the period from 2013 to 2016 was on more disciplined capital allocation, capital and operational efficiencies and debt reduction. Anglo American (2013) stated that its target for 2016 was to increase its return on capital employed (ROCE) from a low of 11% in 2012 to a minimum of 15% in 2016. It intended to achieve this target through applying a new more focussed approach on capital allocation decisions. This new approach entailed a change in the company's investment philosophy where the focus was more on the quality and return profile of the individual asset, as opposed to the previous objective where the focus was more on achieving growth within the preferred range of commodities (Anglo American, 2013). This capital allocation approach also involved significant restructuring of the business with a number of disposals of assets that did not meet the company's investment criteria. During the period from 2013 to 2016 the number of assets within the Anglo American portfolio was reduced from 68 to 42 (Anglo American, 2016).

1.7.2 BHP

BHP commenced operations in 1885 in Australia as Broken Hill Properties with the development of a lead, zinc and silver mine (BHP, n.d.). BHP has its roots in two companies, namely BHP and Billiton who merged in 2001. Billiton has its roots in the discovery of tin at Billiton Island in 1851. In 1860 NV Billiton Maatschappij was established and acquired the mining rights of the Billiton and Banka islands. According to BHP (n.d.), Billiton continued to mine tin on Billiton Island up to 1958.

In 1883 Charles Rasp discovered lead and silver deposits at Broken Hill Properties in western New South Wales (BHP, n.d.). Rasp immediately applied for mining licences at Broken Hill Properties, which led to the establishment of Broken Hill Propriety Company (BHP) in 1885. In 1902 BHP developed flotation technology to enable extraction of zinc that previously was not extractable. This discovery led to the development of flotation technology that made extraction of other minerals also economically viable (BHP, n.d.).

In 1935 BHP completed its first offshore expansion with the development of a bauxite mine on Binton Island in Indonesia (BHP, n.d.). In 1967 BHP discovered significant off-shore crude oil fields in the Bass Strait, Western Australia. In 1968 the first development of an iron ore mine in the Pilbara region of Western Australia was completed by BHP. As a result Port Hedlands was development which is Australia's largest port (BHP, n.d.).

In 1970 the Royal Dutch/Shell group purchased BHP. The capital injection from the Royal Dutch/Shell group enabled BHP to expand across the world and become one of the biggest mineral producers in the world. In 1984 BHP acquired Utah International from General Electric which made BHP a significant coal exporter in Queensland and expanded BHP's operational footprint to Chile, Brazil, Canada and the United States (BHP, n.d.). In 1990 BHP together with Rio Tinto completed the development of Escondida, the largest copper mine in the world.

Gencor, a South African mining company, acquired a major interest in BHP in 1994. This acquisition indirectly led to the merger between BHP and Billiton in 2001. In July 2002 BHP announced the demerger of BHP Steel. On 19 August 2014 BHP announced the demerger of South32 which is a spin out of BHP's alumina, aluminium, coal, lead, manganese, nickel, silver and zinc assets. This allowed BHP to focus on copper, petroleum, iron ore and metallurgical coal as its core focus assets. In 2017 BHP announces a change in name from "BHP Billiton" to "BHP", by removing the word "Billiton" from the name (BHP, n.d.).

1.7.3 Rio Tinto

Rio Tinto traces its origins back more than 150 years to ancient copper mines in Spain (Rio Tinto, n.d.). The ancient copper mines located close to the red river (Rio Tinto) were originally mined in 750 BC and supplied copper to ancient Greece and Rome. In 1873 the Spanish Government sold the mines to a British-European syndicate, which led to the creation of the Rio Tinto Company. Through the development and construction of new processing facilities the Rio Tinto operations were converted into the world's number one copper producing mine from 1877 to 1891 (Rio Tinto, n.d.).

In 1925 a new management team led by chairman Sir Auckland Campbell-Geddes, significantly expanded Rio Tinto's operations overseas to transform the company from a small Spanish company to a multi-national mining house (Rio Tinto, n.d.). In 1954, 80 years after the establishment of the original Rio Tinto copper mines in Spain, 67% of the original mine was sold which provided the required capital to expand operations further across the world (Rio Tinto, n.d.).

In 1956 Rio Tinto in joint venture (JV) with Kaiser Aluminium of the United States of America (USA), developed the vast bauxite deposits of Weipa in Queensland, Australia. In 2000, Rio Tinto became the sole owner of the Commonwealth Aluminium Corporation Pty Ltd, the JV company formed to develop the Weipa bauxite deposits (Rio Tinto, n.d.).

The development of Mount Tom Price iron ore mine in 1966 in the Pilbara region in Western Australia, transformed Rio Tinto into the second largest iron producer in the world (Rio Tinto, n.d.). The acquisition of US Borax in 1968 proved to be extremely valuable to Rio Tinto, as the profits realised by US Borax during the oil crises in the 1970's allowed Rio Tinto to acquire BP Minerals for US$4.3 billion when BP decided to exit all mineral operation in 1989. This acquisition transformed Rio Tinto into one of the world's largest producers of speciality iron and titanium dioxide. In 2007 Rio Tinto completed a US$38.1 billion acquisition of Alcan to become one of the world's largest aluminium producers (Rio Tinto, n.d.).

1.7.4 Vale S.A.

Vale was founded in 1942 by the Brazilian federal government (Vale, n.d.). Vale's original name was Companhia Vale do Rio Doce (CVRD), which was changed to Vale in 2009. The first priority was the mining and export of iron ore mostly to USA, with progressive increase in sales to Europe (Vale, n.d.).

In 1970, after the acquisition of Carajás Mine, Vale become the biggest exporter of iron ore in the world. In 1982 Vale started with the first steps to diversify its production, with the production of aluminium in Rio de Janeiro. Vale was partiallyprivatised in 1997 with the sale of 41.7% interest in the company to Companhia Siderúrgica Nacional for a total amount of R$3.34 billion (Vale n.d.).

During 2001 to 2010 Vale made a number of global acquisition in order to diversify its portfolio base in addition to iron ore. The biggest acquisition was made in 2006 when Vale made an investment of US$18.9 billion to acquire Inco Limited, which was one of the world's largest nickel producers (Vale n.d.).

1.7.5 First Quantum

First Quantum is a Canadian public company listed on the Toronto Stock Exchange. First Quantum has its operational roots in Zambia where in 1996 it acquired the Bwana Mkubwa mining license (First Quantum, n.d.). Bwana Mkubwa is the oldest mining operation in the Zambian Copperbelt, located close to Ndola. In 1998 First Quantum completed the construction of an oxide copper leach processing facility completed with solvent extraction and electrowinning plant to produce copper cathode at Bwana Mkubwa mine (First Quantum, n.d.).

In April 2000 First Quantum together with Glencore acquired Mopani Copper Mines, with its main assets being the existing Mufilira and Nkana Copper Mines. In 2000 First Quantum discovered Lonshi, a copper deposit in the Democratic Republic of the Congo (DRC) through its regional exploration activities. Lonshi copper mine was developed by First Quantum in 2001 (First Quantum, n.d.).

In August 2001 First Quantum acquired 80% of Kansanshi copper/gold deposit which through the mine's development generated substantial value for First Quantum, and allowed it to expand its operations globally. The Kansanhi deposit was developed and expanded by First Quantum in a phased approach from 2002 to 2009. In 2010 First Quantum acquired the Kalumbila copper deposit through the acquisition of Kiwara PLC. An investment of US$1.7 billion allowed First

Quantum to develop the Kalumbila mine in a 300,000 tonne per annum copper mine (First Quantum, n.d.).

In 2003 First Quantum made its biggest acquisition with the acquisition of Inmet Minerals for a total amount of US$5.1 billion. The Inmet acquisition gave First Quantum ownership of the circa US$7 billion Cobre Panama project, which once complete is forecast to produce 400,000 tonnes copper per annum.

1.8 Chapter summary and report outline

This report is structured in nine chapters. Chapter 1 has provided an introduction of the research. The period from 2001 to 2017 has experienced significant volatility in commodity prices and subsequently company valuations. In addition to commodity price, capital allocation also drives company value. Historically, mining companies in general have been unsuccessful at making capital allocation decisions. It has been hypothesized that value can be unlocked through allocating capital on a counter cyclical manner relative to the historical commodity price cycle. The aim of this research is to identify factors to consider during the capital allocation decision-making process that can unlock value in mineral projects. The research is done on five companies which are Anglo American, BHP, Rio Tinto, Vale S.A, and First Quantum over a period from 2001 to 2017. The remainder of the report is described as follows.

In Chapter 2 an overview of methods used to measure the success of capital allocation decisions is provided. A literature review of the various approaches used to perform valuations on mining companies is provided. Best practices in capital allocation are also discussed. Chapter 3 provides a description of the research methodology used. Return on invested capital (ROIC) and ROCE are used to analyse the historical capital allocation success of the five mining companies over a 17 year period that covers the full commodity cycle from low to high. In Chapters 4 to 8 the results from the historical capital allocation analysis for the five mining companies are provided and discussed. Chapter 9 provides a summary of the results and conclusions from the research analysis conducted on the five mining companies. A list of recommendations for further research are also provided in Chapter 9.

2 LITERATURE REVIEW

2.1 Chapter overview

In this chapter literature on value, its definition and the generation of value through capital allocation is reviewed. An overview of the various types of valuation techniques used in the mineral industry is provided in this chapter. Literature on the various types of capital allocation decisions that companies can make is reviewed. An overview of value creation though capital allocation is provided through defining the types of capital, sources of capital and reviewing various capital allocation strategies. Literature on the various capital allocation options available to mining companies is reviewed. Given the importance of measuring the success of historical capital allocation decisions, various measures used to value the success of historical capital allocation decisions are reviewed. Literature on the factors that could influence the success of a capital allocation decision is reviewed. Lastly, an overview of best-in-industry practices is provided that can be utilised by management to increase the probability of achieving better capital allocation decisions.

2.2 Value and mine value approaches

Hallberg (2017) indicated that historically, the general accepted view by classical economists such as Adam Smith, David Ricardo and Karl Marx was that value was dependent on the quantity of labour used to produce or manufacture goods. This remained the predominant view on value until 1870 when three economists, Carl Menger, William Jevons and Leon Walras developed a new concept of value termed the “subjectivist theory of value”. The theory states that value is independent of the quantity of labour used to produce the product, but is solely dependent on the collective views of consumers to what extent the goods satisfies the consumers’ requirements and needs. Hallberg (2017) sated that history proved the subjectivist theory of value to be a superior definition of value, and that the definition led to a significant increase in research dedicated to the theory of value. For this reason Halberg (2017 p174) define value as *“the usefulness of a product or service as subjectively perceived by the individual end consumer”.*

Kumar and Rajan (2017) stated that the subjectivist theory of value is an appropriate measure of value from a consumer perspective, but do not appropriately capture the definition of value from a stakeholder perspective. Kumar and Rajan (2017) further stated that value from a consumer perspective has been extensively studied, but in contrast very little attention has been given to defining value from a stakeholder perspective. Kumar and Rajan (2017) indicated that a noteworthy exception has been by Charreaux and Desbrieres (2001, p4) who defined stakeholder value to be “*a total measure of the rent created by the firm in relation to different stakeholders and not only the sole shareholder*”. Similarly Kumar and Rajan (2017, p144) applied a broader view on the meaning of value with the following definition, “*stakeholder value is the net accrued benefits (tangible and intangible) over the associated costs that firms and individuals realize in commercial exchange process*”. This definition can be restated in more simple terms as the cumulative benefit derived from the project or venture less the cumulative costs incurred in executing the project or venture. The benefits can be in a number of different forms, such as improvement in trust or goodwill, reputation enhancement, increase in community welfare, and monetary benefits. For the purpose of this report it is assumed that value creation refers to net gains in monetary value for stakeholders.

The measure of value to a large degree depends on the kind of organisation and the type of services the organisation provides. For example, for companies involved in providing services to customers Kumar and Rajan (2017) provided a number of different measures of value namely; customer lifetime value (CLV), customer referral value (CRV), customer influence value (CIV), and customer knowledge value (CKV). These measure of value are less appropriate for mining companies as mining companies sell fungible products to the market as opposed to service delivery to customers. It is therefore appropriate to use a different measure of value for mining companies. O'Regan and Moles (n.d.) provided a very simplistic measure of value for a mining project or operation given by Equation 2.1:

$$Expected\ value = (Expected\ revenue - Expected\ costs) \times Risk\ factor \qquad 2.1$$

Where zero or very little risks are expected, a risk factor close to one can be used. As the perceived risk of the mineral project increases a risk factor closer to zero is used. A common measure of the expected value is the net present value (NPV) of the project, which is defined as the sum of the future cash flows in real terms discounted by a project specific risk adjusted discount rate (O'Regan and Moles, n.d.). There are a number of valuation approaches. The common mineral valuation approaches are the market, cost and income approaches (Ellis, 2016).

2.2.1 Market approach

According to Lilford and Minnitt (2005), the market approach, also referred to as the comparable transaction approach, entails the use of previous completed transactions to estimate the value of a mineral asset. Ellis (2016) indicated that the market approach is based on the principle of substitution. The historical transactions should preferably be transactions conducted at arms lengths and where the parties were not forced to conclude a transaction. These transactions can include acquisitions, mergers and disposals.

Baurens (2010) indicated that the market approach relies on the use of a common measurement criteria to estimate the value of an asset based on the historical market valuation of another asset. The measurement criteria used will be different depending on the nature of the mineral asset that is being valued. For example, for a copper exploration asset a common valuation criteria used could be the tonnes of in-situ copper contained in the resource. Using historical market transactions, the valuator would determine dollars paid per contained tonne of copper in the various Mineral Resource categories such as measured, indicated and inferred. According to Lilford and Minnitt (2002), the market approach is typically used for the valuation of mineral properties as there is usually not sufficient information to utilise more accurate valuation techniques such as the discounted cash flow.

The following challenges can be faced when using the market approach (Ellis, 2016):

- There may be a limited number of comparable transactions concluded that can be used as a basis for the valuation. Drawing comparisons between sales are complicated by the amount of debt and cash of the company, and the location, infrastructure constraints, development capital requirements, and geopolitical risks of the properties involved in the sale;
- Each mineral asset is unique which makes it difficult to draw valuation comparisons between various mineral assets. The impact of location, in-situ grade, potential mining methods that can be used, and location to critical infrastructure make it difficult to accurately utilise the value placed on one mineral asset to determine the value of another asset; and
- The process to identify and select similar transactions is subjective and could influence the valuation result.

For the reasons listed above Ellis (2016) indicated that ideally a minimum of two of the three valuation approaches must be used to value mineral assets. If possible Ellis (2016) recommended the use of both the income approach and market approach to inform a valuation appraisal of a mineral asset, as the results from the one approach is used to cross check the results from using the other valuation approach.

2.2.2 Cost approach

The cost approach, also referred to as the appraised value approach, is based on the idea that the value of an exploration asset is equivalent to the qualified historical expenditure spend on the asset plus warranted future expenditure required to delineate and estimate the size of the mineral asset (Lilford and Minnitt, 2005). According to Lee and Strang (2003), the underlying principle of the cost approach is that the purchaser of a mineral asset should compensate the seller of the asset for legitimate historical costs incurred on the asset. For past expenditure to qualify as expenditure that contributes to the value calculation, the expenditure needs to be linked to the exploration costs associated with the discovery and delineation of the mineral asset. The expenditure also needs to be fairly recently incurred, typically within a period of three to five years prior to the valuation date (Baurens, 2010).

With the cost approach the value of a mineral asset is based on the actual qualified costs spend on the asset plus a premium if the results from the exploration activities are positive, or a discount if the results are negative (Baurens, 2010). Baurens (2010) also stated that the cost valuation approach is best utilised on exploration assets that are actively being explored, and that it is more difficult to utilise this valuation approach on assets where exploration activities were stopped some time back. The major disadvantage of the cost valuation approach according to Baurens (2010), is that it takes experience to quantify which historical expenditure qualify to be taken into consideration for the valuation, and that since it is a subjective exercise it does open the valuation up to potential inconsistencies and abuse. In order to limit the potential for abuse or inaccurate valuations, it is advisable to compare the results obtained from the cost approach with valuation obtained from other valuation techniques such as from the market approach.

2.2.3 Income approach

According to Lilford and Minnitt (2005) the income valuation approach is based on the valuation of future net cash flows that will be derived from investment in a mineral asset. The income approach considers; sales, operations costs, capital costs, taxation and working capital movements to derive a schedule of future net cash flows. The schedule of net cash flows is then typically converted into a risk adjusted real term net cash flow schedule which is used to determine the NPV of the mineral project or operation. Lilford and Minnitt (2005) describes the following three techniques that form part of the income approach:

- discounted cash flows;
- tail margin analysis; and
- real option pricing.

These three valuation techniques are discussed briefly below.

According to Lee and Strang (2003) the discounted cash flow (DCF) method is the most commonly used income approach valuation method. The DCF analysis involves determining the revenue and future costs for a mining operation or project. As one of the outputs a DCF analysis determines the NPV of an investment. Typically during the initial capital investment period the cash flows will be negative. Later in the life of the mining investment the cash flows may turn to positive when income from sales starts to exceed the cost of production. The future cash flows are discounted to present day value using a discount rate. Park and Matunhire (2011) stated that the discount rate typically has many sub-components to it which include the cost of capital for the investor and an appropriate risk premium to cover the risk of the investment which should include technical, economic and political risks.

Lilford and Minnitt (2005) indicated that the tail margin method is an extension of the DCF method, used to determine the value of an entire Mineral Resource whilst a DCF analysis only considers the Mineral Reserves. It can also be used to determine the value of mineral rights adjacent to an existing operating mine. The premise of the valuation method is to utilise the known steady state unit costs of the actual operation and to apply them to the balance of the Mineral Resources, in order to calculate the value of the balance of Mineral Resources not covered within the Mineral Reserve footprint.

According to Samis *et al*., (n.d.) dynamic DCF and real option discounted cash flow (RODCF) analysis represent alternative valuation methods within the income approach. Conventional static DCF analysis assumes that inputs used in the valuation such as metal prices do not have uncertainty associated with them. The dynamic DCF and RODCF attempt to consider and incorporate the measure of uncertainty associated with the inputs used in the financial model (Samis *et al.*, n.d.).

2.3 Value creation in mining

The role of management is to create value for stakeholders and let the stock market determine the quantum of the value created. Often management are too concerned about short-term stock price movements instead of focussing on creating long-term value (Buffet, 2011). Long term value creation is important especially for mining companies where capital allocation decisions span across long periods for the following reasons:

1. Mining investment projects typically run for 7 to 10 years before operations start to become self-sustaining and generate free cash flow. This is due to the capital intensive nature of the business and the long durations required to bring a new mine into operation.
2. Mining operations typically run in excess of 20 years, and therefore typically span a number of commodity price cycles. Decisions to time the market often do not work and investment criteria should rather look at long term fundamentals.

There are many ways in which mining companies can create value for stakeholders. One of the ways is though efficient capital allocation, in which the return on capital employed is higher than the cost of capital plus an appropriate risk premium to compensate the investor for the risk undertaken in the project or operation (Pidun and Stange, 2017).

2.4 Value creation through capital allocation

According to Pidun and Stange (2017), research conducted by the Boston Consulting Group has revealed that companies with market capitalisation within the top third relative to their peers invest up to 50% more capital than their peers. In addition these companies also achieve approximately 55% higher return on capital invested. There are various forms or types of capital as described in the next sub-section.

2.4.1 Types of capital

Piketty (2014, p38) provides a three-fold definition of capital, namely:

- In relation to wealth: "*capital is defined as the sum total of non-human assets that can be owned and exchanged on some markets. This includes all forms of property as well as financial and professional capital used by firms and government agencies*";
- In relation to property and the market: "*capital includes all forms of wealth that individuals can own and that can be transferred or traded through the market on a permanent basis*"; and
- In relation to accumulation: "*capital is a stock and refers to all the wealth accumulated at a given point in time*".

Goodwin (2003) indicated that there are five different types of capital namely; financial, natural, produced, human, and social. He stated that all the types are capable of creating economic activity that leads to desirable outcomes. In this report capital is referred to as financial or economic capital. The source of capital is an important consideration for mining companies as it has a direct impact on a mining companies' weighted average cost of capital (WACC) and the type of projects the mining company invest in (Park and Matunhire, 2011).

2.4.2 Sources of capital

According to PwC (2013), there are three categories of capital sources available to mining companies namely; equity, debt and alternative funding. Equity funding according to PwC (2013) can either be public equity such as an initial public offering (IPO), or alternatively private equity funding. Debt funding can either be private or public debt. Alternative sources of capital according to PwC (2013) can either be royalty financing or stream financing.

According to the Pecking Order Theory, management chooses to fund capital requirements firstly with cash generated internally, secondly from short-term debt, thirdly from long-term debt and lastly from equity (Myers and Majluf, 1984). Chen (n.d) further evaluated the most important factors influencing a firm's capital structure. Chen (n.d.) concluded that the most important factors that influence the mechanism in which companies raise capital are profitability and growth rate. The more profitable a firm is the more the company will be inclined to use their earnings to fund their capital requirements. According to Chen (n.d.), companies that historically achieved high growth rates are more inclined to use debt to finance their capital requirements. Larger companies are also more inclined to make use of debt due to its tax write-off benefits (Chen, n.d.).

Higher transaction costs associated with debt and equity also causes companies to choose to use earnings where possible to fund capital requirements (Gaud *et al*., 2005). This is due to no transactions costs associated with financing from internal sources. After establishing the source(s) of capital the next important consideration is the allocation of the capital. A number of different options exist for capital allocation.

2.4.3 Capital allocation

According to Balog (2010), capital allocation refers to the distribution of financial capital to different business sectors. Mauboussin and Callahan (2014a) stated that capital allocation is the most important concern for management. They stated that capital allocation involves the directing and application of resources to create something more valuable than the sum of the inputs. Companies typically utilises capital to either build new production capacity, maintain production capacity or expand existing production capacity. In the context of this research capital allocation refers to the distribution of financial capital by firms to either sustain, acquire or grow mining production, or return capital to shareholders.

Mauboussin and Callahan (2014a) provided the following five principles for value creation during the capital allocation process:

1. "Zero-based capital allocation;
2. Fund strategies, not projects;
3. No capital rationing;
4. Zero tolerance for bad growth, and;
5. Know the value of assets and be prepared to take actions"

The last principle is fundamental in best-in class capital allocation. It is important to be able to accurately determine the value of an asset, as this enables management to take action if there is a significant variance between the calculated value of an asset and the market perceived value of the asset.

Buffet (2011, p6) stated that the first law of capital allocation is: "*What is smart at one price is dumb at another*". Therefore, correct valuation of a mining asset is at the heart of best-in class capital allocation decisions. Since views and perception of long term commodity prices have such a significant influence on the valuation of mineral assets, companies have to be very cautious when making capital allocation decisions when commodity prices are at historical highs or lows. Buffet (2011, p6) also stated that management that are more successful in capital allocation decisions are guided by a resolute view of value and are not easily swayed or confused by short term market changes. The importance of this is to always make decisions based on the long term market fundamentals and not be influenced by short term variability. A good example of this is mining companies divesting from mining assets and operations during the bottom of the commodity price cycle and acquiring lower quality mineral assets during the top half of the commodity price cycle.

Mauboussin and Callahan (2014a) argued that many chief executive officers (CEO) of companies are not skilled in capital allocation decisions. The lack of skills in capital allocation according to Mauboussin and Callan (2014a) citing Buffet (2011) are due to the following reasons:

- Many heads of companies are selected based on their excellence in their core business expertise, and are often ill-equipped to make effective capital allocation decisions; and
- Most heads of companies have no or very little experience in capital allocation decisions.

2.5 Capital allocation decisions

Mauboussin and Callahan (2014a) argued that even though capital allocation enables the potential growth of a company, growth should not be the primary driver of capital allocation decisions. They stated that capital allocation should rather be guided by increasing the long term-value per share of the company. An example of this is large mining companies which acquire mining projects and operations at the top of the commodity cycle to fuel the growth aspirations of the company. According to Jordan *et al.* (2013), significant capital write-downs during the subsequent down turn in the commodity cycle have proved that growth does not always result in long term wealth creation. Mauboussin and Callahan (2014a) listed a number of alternative options for the allocation of capital. These alternatives are discussed in the next sub-sections.

2.5.1 Capital allocation to mergers and acquisitions

Mauboussin and Callahan (2014a) stated that the largest percentage of the overall capital allocated is utilised for M&A. M&A activities usually increase when commodity prices are relatively high. This is reflective of the 2004 to 2007 commodity price boom when the value of M&A transactions increased by 227% between 2004 and 2007 (PwC, 2007). For mining companies, M&A represents a significant means for them to achieve their desired strategic outcomes. M&A makes it possible to acquire operating operations without having to incur the risk and time durations associated with developing mining projects. This does however potentially come at an additional cost compared with the alternative of developing a similar new mine, since the operation would have been de-risked to a certain extend. On the other hand it may also present an opportunity to buy the operations at a discount compared to the original capital invested, specifically in cases where the project did not deliver on its original investment expectations (Mauboussin and Callahan, 2014a).

Mauboussin and Callahan (2014a) also stated that M&A activities typically increase in value and frequency during times of higher share price valuations. Since there is typically a very strong correlation between the prevailing commodity prices and the share price performance of mining companies, it is therefore plausible that M&A in the mining industry are typically more frequent during the peak of the commodity cycle. However, during this time it may be more prudent to be more cautious since there is a significant risk of over valuations of mining operations and paying too much for the acquisition. The US$38billion acquisition of Alcan Inc. in 2007 by Rio Tinto is a prime example of this. Rio Tinto announced approximately US$11billion in capital impairments in relation to the acquisition due to falling aluminium prices in years after closure of the deal (Rio Tinto, 2013).

According to McNamara *et al.* (2008) M&A typically happen in waves within an industry. Early movers in the merger and acquisition wave tend to conclude deals when commodity prices are in the bottom half of the cycle, whilst late movers conclude deals at the top of the cycle. McNamara *et al.* (2008) stated that there are potentially significant advantages gained by being an early mover in the merger and acquisition wave. The early movers can obtain a strategic advantage in the cost of the acquisition. Since company valuations are typically lower at the bottom of the commodity cycle the early movers can potentially acquire assets at comparably lower costs. Late movers tend to be caught up in the bandwagon effect of the number of M&A concluded at the top of the wave. The risk at the top of the wave is over paying for the acquisition since company valuations then tend to be high by historic standards.

2.5.2 Capital allocation to expand and sustain operations

Expansionary capital and sustaining capital attracts the second highest amount of capital allocation (Mauboussin and Callahan, 2014a). Mining companies are by nature capital intensive, with a significant amount of capital required per annum to sustain production output. Expansion capital refers to capital allocated to projects that increases production volumes, whilst sustaining capital refers to capital expenditure required to sustain current production volumes (Ter Weer, 2016).

Capital expenditure in mining companies, which includes both expansion and sustaining capital expenditure, tends to follow the same pattern as M&A in mining companies (Jordan *et al.*, 2013). The reasons for this is similar to the reasons for increased merger and acquisitions during periods of above average commodity prices. The risk is that companies may add too much additional production capacity at the top of the commodity price cycles which then adds to the over production levels when commodity prices drop.

Mauboussin and Callahan (2014a) concluded that companies that invest in high quality growth projects typically have higher market valuations compared to companies that invest in marginal projects. The challenge for mine management is to identify the high quality growth projects and resist the temptation to invest in marginal projects when the commodity prices are high by traditional standards.

2.5.3 Capital allocation towards research and development

Mauboussin and Callahan (2014a) indicated that research and development (R&D) is a form of capital allocation that shows on the income statement as opposed to capital expenditure and merger and acquisitions that are recorded on the balance sheet. R&D is typically expensed in the same year so the potential down-the-line benefits are difficult to quantify.

2.5.4 Capital allocation through divestment

Value can also be created by disposal of company assets if the assets are deemed to be more valuable in the hands of the buyer. In order to create value through disposals it is important to have a good understanding of the value of the asset to ensure that value is not destroyed when the asset is sold.

According to EY (2016), divestment or sale of assets are frequently used by mining companies to balance their portfolio of mines. EY (2016) stated that historically mining companies have used divestment as a tool to diversify their commodity production and thereby reduce risk. However, EY (2016) indicates that most recent divestments concluded by mining companies between 2013 and 2016 has been due to a requirement to rebalance their balance sheets and reduce debt. EY (2016) suggested that mining companies could potentially unlock more value through adopting a more long term strategic view of the preferred list of commodities produced, and use divestment as one of the tools to achieve the strategic objective.

Mauboussin and Callahan (2014a) stated that divestures typically draws less attention than merger & acquisitions but generally form a large percentage of the overall capital allocation value. Spin-off is another form of divesture, where a certain number of mines within a mining company are bundled to form a separate company which is split from the parent company. A recent example of a spin-off was the creation of South32 out of BHP (BHP, 2015). Mines within BHP that produced commodities outside of the core focus commodities were bundled in a separate company which led to the creation of South32 (BHP, 2015).

The rationale for spin-offs according to Mauboussin and Callahan (2014a) is that the majority of value in a mining company is generated by a few assets within the company, whilst the remaining balance of mines within the company contribute very little to the value of the overall company. The mines contributing a smaller percentage of the overall value may still require a relatively large component of the overall capital allocation, which may have been better spent on the few mines that generate the bulk of the value in the company. In this instance it may be better to divest or spin off the lower value contributing mines which may generate more value in the hands of a different owner. Mauboussin and Callahan (2014a) referred to this scenario as “addition by subtraction” where value is added to the mining company through divesting of an operation that provides a lower return on capital invested. This scenario is sometimes the most difficult for companies’ executive management to act on, as the natural inclination is to grow mining companies and not to sell operations. A recent example of the “addition by subtraction” scenario is Anglo American who over the period from 2013 to 2016 divested 26 operations, which reduced the number of mines from 68 to 42 (Anglo American, 2016).

2.5.5 Capital allocation to shareholders

Dividends are another form of capital allocation where portions of profits are paid to shareholders. Mauboussin and Callahan (2014a) stated that dividends and share buy backs are the two main capital allocation methods that companies use to return cash to shareholders.

2.6 Measures of value realised from capital invested

Mauboussin and Callahan (2014a) provided a three-step framework for measuring a company's capital allocation success and the value added through capital allocation. They stated that the first step is to determine how the company has allocated capital historically, completed in two parts:

- Part 1 evaluates how companies have historically allocated capital towards operations, which can be in the form of capital expenditures, M&A, working capital and research and development.
- Part 2 evaluates how companies have returned capital back to shareholders which can be in the form of dividends, debt repayment and share buybacks.

The second step is to determine the company's return on invested capital. According to Faulkenberry (n.d.), the following metrics can be used to calculate return on capital invested or employed:

- ROIC;
- Cash return on invested capital (CROIC);
- ROCE; and
- Return on average capital employed (ROACE).

Mauboussin and Callahan (2014b) suggested that the best accounting metric to measure capital efficiency is ROIC. ROIC provides a measure of how efficiently a company employs its overall capital. Equation 2.2 shows the formula to calculate ROIC (Mauboussin and Callahan, 2014b):

$$ROIC = \frac{NOPAT}{Sales} \times \frac{Sales}{Invested\ Capital} \qquad 2.2$$

Where NOPAT is Net Operating Profit after Tax which is calculated using Equation 2.3 (Mauboussin and Callahan, 2014b):

$$Net\ operating\ profit\ after\ tax\ (NOPAT) = Earnings\ before\ interest, tax, amortisation\ and\ depreciation\ (EBITDA) - cash\ taxes \qquad 2.3$$

Invested capital is calculated using Equation 2.4 (Mauboussin and Callahan, 2014b):

$$\begin{aligned} Invested\ capital = {} & Current\ assets \\ & - non\ interest\ bearing\ current\ liabilities \\ & + net\ property, plant\ and\ equipment \\ & + goodwill \\ & + other\ operating\ assets \end{aligned} \qquad 2.4$$

Koller *et al*. (2010) stated that ROIC may be distorted for companies with large variable capital expenditure and may not provide an accurate indication of the return on capital achieved. In this scenario Koller *et al*. (2010) argued that CROIC may present a more accurate measure of return on capital employed. According to Faulkenberry (n.d.), CROIC is a variation of ROIC where NOPAT has been substituted with free cash flow (FCF). CROIC provides an indication of the amount of cash generated by a company for the invested capital. CROIC according to Faulkenberry (n.d.) is calculated using Equation 2.5:

$$CROIC = \frac{FCF}{Invested\ capital} \qquad 2.5$$

Where, FCF is calculated using Equation 2.6 (Faulkenberry, n.d.):

$$FCF = Operating\ cash\ flow\ (OCF) - capital\ expenditure \qquad 2.6$$

According to Faulkenberry (n.d.) ROCE is calculated using Equation 2.7:

$$ROCE = \frac{Earnings\ before\ interest\ (EBIT)}{Capital\ employed} \qquad 2.7$$

Where capital employed is calculated using Equation 2.8 (Faulkenberry, n.d.):

$$Capital\ employed = Total\ assets - \ current\ liabilites \qquad 2.8$$

In Equations 2.2, 2.3 and 2.7 the following two major differences can be seen between ROIC and ROCE:

- ROIC makes use of EBITDA in the calculation, whilst ROCE uses EBIT. ROIC therefore excludes the effect of amortisation and depreciation, whilst ROCE takes amortisation and depreciation into account. According to Faulkenberry (n.d.), the inclusion of amortisation and depreciation in the ROCE calculation makes it difficult to make comparisons on ROCE between different organisations. Companies can treat amortisation and depreciation differently which has a direct impact the ROCE for the entity; and

- ROIC calculates return on capital employed after tax, whilst ROCE calculation is before tax (Faulkenberry, n.d.).

According to Faulkenberry (n.d.), ROACE is calculated using Equation 2.9:

$$ROACE = \frac{Earnings\ before\ interest\ (EBIT)}{Average\ capital\ employed} \qquad 2.9$$

Where average capital employed is calculated using Equation 2.10 (Faulkenberry, n.d.):

$$Average\ capital\ employed = Average\ total\ assets - \ average\ current\ liabilites \qquad 2.10$$

The difference between ROCE and ROACE is that, ROCE provides a measure of the return on capital employed at a specific point in time which is typically the financial year-end, whilst ROACE provides the average return on capital employed over an accounting period which is usually a year. The average capital employed is taken as the mean of the opening capital and closing capital for the accounting period (Faulkenberry, n.d.).

For measurement of the success of a merger or acquisition McNamara *et al.* (2008) proposed that a different metric be used. They stated that traditional accounting based measures are not always the most appropriate measures of success of a merger or acquisition transaction. They proposed that based on the work done by Ramaswamy (1997) cumulative abnormal returns (CARs) is a more appropriate method to measure merger or acquisition performance. Abnormal returns is defined as the difference between actual returns after completion of a merger or acquisition and the expected returns if the merger or acquisition did not materialise (McNamara *et al*., 2008). McNamara *et al.* (2008) provided the following reasons for proposing CARs as a better method to traditional accounting based methods in the measurement of the performance of a merger or acquisition:

- The effect of an acquisition typically takes six months to three years before the effect of the acquisition or merger can be measured; and
- During this period many other factors may influence the company performance, such as commodity prices, volume output, cost escalation, and fiscal changes, which may impact on the performance of the company. All these other factors makes the measurement of the performance of the merger or acquisition very difficult when traditional accounting based measures are used.

In this research study ROIC and ROCE were used as the metrics to measure the success of capital allocation decisions. ROIC was used because of the argument provided by Mauboussin and Callahan (2014b) that ROIC is the best accounting metric to measure capital efficiency. ROCE was used because by excluding the impact of tax on the returns on capital achieved, it provides a more direct comparison on the operational performance between mining companies across different tax jurisdictions.

In the third step of Mauboussin and Callahan's (2014a) three step framework the reasons for the capital allocation decision-making are analysed to identify any incentives and / or corporate governance that may have influenced the decision-making process. Mauboussin and Callahan (2014a) also highlighted the following aspects to consider in analysing a company's historical capital allocation decisions:

- Analyse trends in the capital allocation decisions. The following questions must be asked; "*Are capital expenditure rising over the period? Is preference given to merger and acquisition activity over capital expenditure?*"

- Any changes in capital allocation patterns typically occur with a significant change either external or internal to the company. For example a dramatic drop in capital expenditure may occur after a sudden weakening in the prices of commodities that the company produces.

As part of the measurement of a company's capital allocation success it is important to consider external and internal factors that may impact the returns realised from capital investments. The next section discusses the various internal and external factors that could impact a company's capital allocation success.

2.7 Factors affecting value creation from invested capital

A number of internal and external factors may have an impact on the success of a company's capital allocation strategy. These factors are discussed in the next sub-sections.

2.7.1 Impact of timing of the capital allocation decisions on the success of the decision

The mining sector is unique in the sense that it operates in a cyclical market where external market forces impact capital allocation decisions. During the upward trajectory period in the commodity pricing cycle, mining companies have traditionally been rewarded by the market through higher market valuations for demonstrating good growth prospects (Nangolo and Musingwini, 2011). This reward for higher growth, and higher operational margins obtained from the more favourable commodity prices has to a certain extent in the past influenced management's decision-making in allocating capital to potential lower margin and less profitable operations.

McNamara *et al.* (2008) mentioned that merger and acquisition activities tend to happen in waves. This is defined as short periods of above normal value of mergers and acquisition within a specific industry. They defined a merger wave as any six year period where the peak year containing the highest transaction value in mergers is at least double the value of the mergers in year 1 of the period. Additionally, the value of mergers should decline after the wave to at least half the value of the mergers in the peak year.

Through analysis of the outcome of a number of historical merger and acquisition transactions, McNamara *et al.* (2008) concluded that different performance outcomes are normally obtained depending on when the capital allocation was initiated in relation to the industry cycle. They also further concluded that companies that transact late in a merger wave have worse performance outcomes if the transactions are mostly stock based. They recommended that late movers in a merger wave should consider using cash to fund the transactions, instead of using debt financing.

2.7.2 Risks and uncertainties

According to Park and Matunhire (2011), uncertainty in a mining investment introduces risk that can be a potential hindrance to value creation. They categorised risks in the following ways:

1. Technical risks – technical risks according to Park and Matunhire (2011) can be further sub-divided into three categories:
    i. Mineral Reserve risk – this risk relates to the probability of the actual *in-situ* Mineral Resources being different from the estimated Resource in terms of size and quality.
    ii. Completion risks – this reflects the risk associated with the execution of the project, where the project may be late, cost more than estimated, or have inherent design flaws.
    iii. Production risks – these are risks associated with the production phase of a project, where the operational mine may not achieve the production schedule, or not meet its functional specifications, such as recovery targets or quality targets.

2. Economic risks – economic risks according to Park and Matunhire (2011) can also be sub-divided into three categories:
    i. Price or revenue risk – this risk relates to the probability of different mineral prices compared to the assumed mineral prices used in the economic valuation. This risk is one of the biggest risks in a discounted cash flow analysis as it directly affects sales.
    ii. Demand/supply risk – this reflects the risk associated with future fluctuations is supply and demand balance for the commodity that will be produced. The demand and supply balance typically has a large influence on the commodity price.
    iii. Foreign/exchange rate risk – most mineral projects have a certain degree of foreign exchange rate risk due to the capital goods typically being supplied from foreign suppliers who quote in a different currency to the host country's currency. If a mine is located in a country where the local currency is different from the base currency in which project costs are being measured, there will potentially be foreign exchange rate risks associated with local currency costs. An example of this is local salaries which may be paid in a different currency compared to the base currency used in the project.
3. Political risks – political risks according to Park and Matunhire (2011) can be sub-divided into four categories:
    i. Currency convertibility risk – this risk is associated with the foreign exchange controls that the host country may have. For example there may be a limit to the amount of foreign exchange that can be bought in a single period.
    ii. Environmental risk – Park and Matunhire (2011) argued that environmental regulation can impact the financial returns on a project in three different ways. Firstly, the environmental requirements can increase the capital and operational costs of the project. An example of this is the requirement to line a tailings storage facility with a plastic liner to prevent ground water

contamination. Secondly, requirements of the environmental regulations can increase the time spend on non-mining activities, such as the requirement to conduct base line environmental and social studies during the environmental impact assessment. Thirdly, the environmental authorities in many cases have the rights to suspend project construction and or operations if certain environmental regulations are breached. This risk can have profound negative impact on the capital and operational costs of a project.

iii. Tax policy – this risk relates to the potential changes in tax and fiscal policies that the host authorities may introduce over the life of mine. An example of this is the substantial increase in mineral royalty taxes that Zambia introduced in 2014.

iv. Nationalization – Nationalization of mines becomes a risk when the compensation paid to government for the use of the Mineral asset is lower than the real value of the asset.

2.8 Guidelines for the capital allocation decision-making process

Hanson and Patterson (2013) provided the following guidelines for the capital allocation decision-making process which can potentially unlock more value for stakeholders:

1. Have a clear definition of the minimum criteria a project needs to meet before capital is allocated to a project. Hanson and Patterson (2013), indicates that the minimum criteria could include a number of different metrics aligned to the strategic objectives of the company such as, minimum return on investment, reduction in the risk profile of the company, and minimum safety criteria.
2. The amount of contingency and financial reserves allowed for in the project's capital estimate should be clearly defined. The contingency

amount should be appropriate for the calculated level of risk of the project. Various stochastic techniques such as Monte Carlo simulation should be used to determine the level of risk in the capital definition. Depending on the level of calculated risk, companies should develop standards that define the amount of contingency that should be allowed for.

3. The level of mandatory capital expenditure allowed for in the capital estimate should be clearly defined. Mandatory capital expenditure includes the levels of capital spending that is prescribed by law, for example an off-gas scrubbing plant for a smelter complex to meet environmental legislation.

Deloitte (2014) provided the following strategies that can be adopted by mining companies to improve capital allocation decisions and thereby unlock value:

1. Continuous review of in-house project business cases to ensure that their inherent risks are still acceptable. The external environment, such as the macro-economic conditions, continuously changes and may impact on the optimal capital and technical definition of a project.
2. Optimisation of the portfolio of capital allocation opportunities that a company may have. This optimisation process ranks the various capital allocation opportunities using the company's minimum investment criteria as a guideline.
3. Companies typically report on consolidated operational and capital expenditures. To avoid over investment in a sub-optimal project each project should be evaluated on its own merit, taking into account the project's capital intensity and returns that the project will realise.
4. Predictive project analytics (PPA) should be utilised to make more accurate predictions on the likely outcome of a project. PPA makes use of data from a large number of completed projects, and through measuring certain key indices can make more accurate predictions of the final outcome of a project.

5. Consideration should be given to developing mines in phases which can substantially reduce project risk through limiting capital commitments at any one point in time.
6. Through paying closer attention to talent management, mining companies can potentially enhance cash flows from existing mines without having to commit to significant capital expenditures.

2.9 Chapter summary

Value can be created and destroyed through capital allocation decisions. Before a capital allocation decision is made a valuation of the mineral asset should be done. The main mineral asset valuation approaches are; the market, income and cost approaches. The most appropriate valuation method is dependent on the development phase of the project or operation. For a project or operation that is already in production and generates cash flow the income approach is typically the most appropriate valuation technique. For mineral projects that are still in development phase the market approach is typically used, where the project is valued based on its Mineral Resources relative to other projects where successful sales or acquisitions have been completed. For exploration projects that do not have a Mineral Resource declared the cost approach is typically used to value the project.

Because of the scarcity and high cost of capital, a high return on capital invested should be achieved. The following methods can be used to calculate return on capital invested or employed, ROIC, CROIC, ROCE and ROACE. ROIC provides a measure of how efficiently a company employs its overall capital, and has been referred to as the best accounting method to measure capital allocation success or failure. CROIC is a variation of ROIC where NOPAT is substituted with FCF. CROIC provides an indication of the amount of cash generated by the company for the invested capital. ROCE provides a measure of the return on capital employed at a specific point in in time which is typically a financial year-end, whilst

ROACE provides the average return on capital employed over the year. ROIC and ROCE are selected as measures of return on capital invested in this research.

The success of capital allocation decisions are influenced by the stage in the commodity cycle that the decision are made. Historical outcomes have indicated that there are arguably a greater chance of success or failure when capital allocation decisions are made at historical highs or lows in the commodity price cycle. Management needs to take this into account and be cautious in making capital allocation decisions at times when the underlying commodity price is high or low compared to the historical cycle.

As with any investment it is important that companies have a clear understanding of the minimum investment criteria an investment needs to meet before a capital allocation decision is made. It is recommended that a company frequently monitors its portfolio of capital allocation opportunities. Consideration should also be given to develop or allocate capital in stages therefore limiting the capital exposure and risk associated with the investment. The research methods used to analyse the capital allocation decisions of the selected companies are described in the next chapter.

3 RESEARCH METHODOLOGY

3.1 Chapter overview

This chapter describes the research methods that were used to analyse the capital allocation decisions of the selected companies. The data collected, data sources as well as the data analysis methods are outlined in this chapter. The analysis focussed on five mining companies as listed and their selection explained in Chapter 1. The analysis was based on specific accounting metrics that are key indicators of the capital allocation performance of the selected mining companies. The accounting metrics were calculated for each company over a 17 year period.

3.2 Data collected and analysis of capital allocation of the selected mining companies

The framework provided by Mauboussin and Callahan (2014a) was used as a guideline to determine the capital allocation success of the selected mining companies from 2001 to 2017. The research focussed on the following mining companies as explained in Chapter 1:

- Anglo American;
- BHP;
- Rio Tinto;
- Vale S.A.; and
- First Quantum.

The capital allocation analysis followed a nine step process as outlined in the next sub-sections.

3.2.1 Step 1 – Review of capital allocation

The first step involved determining the allocation of capital by each mining company to either buy assets, develop assets or return money to shareholders. Figure 3.1 shows the total amount of capital allocated by 88 listed mining companies to these three categories (EY, 2015). Similar graphs were developed for each mining company.

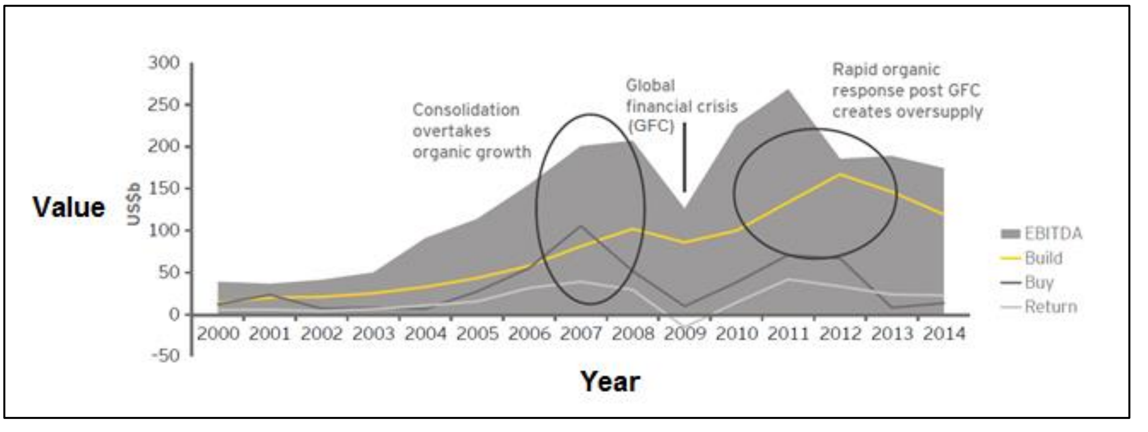

Figure 3.1: Capital allocation by 88 listed mining companies

(Source: EY, 2015)

In Figure 3.1 build, buy and return are defined as follow:

- Build refers to capital allocated to expansion capital, stay-in-business capital and exploration expenditure;
- Buy represents merger and acquisitions through either debt, equity or cash financing; and
- Return represents dividend payments to shareholders and share buy-back programmes.

A similar analysis was completed for each of the five mining companies, where capital allocated to build, buy and return activities were analysed in relation to the prevailing commodity price.

3.2.2 Step 2 - Overview of historical financial performance

The next step done was to provide a brief overview of the financial performance of each company over the period from 2001 to 2017. Included in the overview are a review of revenue, operational costs, capital costs and earnings before interest, tax, depreciation and amortisation (EBITDA) in real 2000 money terms over the 17 year period. Important insight was obtained on the relative success of capital allocation by the five mining companies over the 17 year period based on the growth, or lack of growth of revenue and EBITDA over the period. The data for this financial overview was obtained from the companies' respective annual financial statements.

3.2.3 Step 3 – Review of revenue, basket commodity price and production volume growth

In this step the sales contributions per commodity produced by each company were analysed. Next a basket commodity price index weighted by each commodity's contribution to sales (BCPI) was determined. Important insight was derived from comparing the amount of capital allocated to growth opportunities in relation to the prevailing basket commodity price. Lastly, a production volume unit index was calculated that provides an indication of the production volume growth achieved over the 17 year period. All information in this analysis was obtained from the respective companies' annual reports.

The steps followed to determine the BCPI are outlined below:

1. Firstly, the nominal average annual commodity price of the all the commodities produced by the company were determined for the period 2001 to 2017.
2. The nominal average annual commodity prices were converted to real 2000 money terms commodity prices using the annual United States of America Consumer Price Indices.

3. The unit commodity price for each commodity produced was calculated by dividing the real term commodity price in the year of measurement, with the average real term commodity price over the entire cycle of measurement, from 2001 to 2017. For example, for Anglo American in 2007 the annual average copper price realised was calculated as US$4,743/tonne in real 2000 money terms, whilst the average realised copper price in real 2000 money terms over the period from 2001 to 2017 was US$4,128/tonne. The unit sales price index for copper in 2007 was therefore 4,743 / 4,128 = 1.15. The commodity price index was determined for every commodity produced by the companies over the period from 2001 to 2017.
4. The sales revenue derived from each commodity produced per annum, was determined by multiplying the real terms average commodity price with the respective volumes produced per annum for the specific commodity.

- The percentage sales contribution from each commodity towards the total sales achieved in the year, was calculated by dividing the sales revenue derived from the commodity with the total sales achieved in the particular year. For example in 2007 Anglo American derived US$3,611million revenue in real 2000 money terms from copper sales, whilst the total annual sales revenue in 2007 was US$21,090million. Copper's sales contribution as a percentage of total sales was therefore 3,611 / 21,090 = 17.1% in 2007. This calculation was done for each company for each commodity produced from 2001 to 2017;

5. The BCPI in each year was determined by calculating the sum product of the commodity price index for each commodity and the percentage contribution of sales derived from the commodity in the particular year. Using the copper example above, the calculation would be 1.15 multiplied with 0.171% = 0.19665. The results from these calculations for each commodity and mineral produced were added together for each year to determine an overall BCPI for each year.

The BCPI is a weighted basket commodity price index weighted by sales where the commodity price was normalised with respect to the average real terms commodity price over the cycle. A BCPI value of one indicates that the basket price in the year of measure was equal to the real terms average basket price of commodities produced during the period 2001 to 2017. A BCPI value greater than one means that a higher real term basket price was achieved in the year of measure compared to the average price over the period, and a BCPI value less than one indicates a lower basket price in that year. Useful insight into the capital allocation strategy employed by a mining company was obtained through comparing the amount of capital allocated per annum versus the BCPI.

The final step in this sub-section involved the calculation of a production volume index (PVI). The PVI was calculated through dividing the total sales revenue per annum in real 2000 terms by the BCPI. This provides a relative indication of the production volumes achieved in the particular year. The annual index values for 2001 to 2017 were then divided by the PVI value in the year 2001 to obtain an indication of the production volume growth relative to the production values in 2001.

3.2.4 Step 4 – Review of capital commitments

Capital allocations measurements as described in sub-section 3.2.1 only takes into account capital expenses that have been accrued. This typically means that services has been rendered and an invoice has been issued by the services provider. There can be a substantial time delay between when capital was approved by a company compared to when the capital is expensed. It is also important to understand the relationship between the amounts of capital committed by a company in relation to the prevailing commodity price at the time of approval. EY (2015) indicated that there is generally a strong correlation between the prevailing commodity price and the amount of capital approved or committed. The relationship between the prevailing commodity basket prices of the commodities produced by the company, and the amount of capital allocated were determined for each of the five companies.

3.2.5 Step 5 – Review of distribution to shareholders

Distributions to shareholders are one of the capital allocation options. Typically capital is allocated to shareholders through either dividend payments or share buy-back programmes (EY, 2017a). The amount of capital allocated to shareholders in relation to the prevailing commodity prices can provide valuable insight into the capital allocation strategy followed by the mining company. In this step the amounts of capital allocated to shareholders as a percentage of revenue were determined for the period 2001 to 2017.

3.2.6 Step 6 – Review of balance sheet strength

A key question for a mining company producing commodities with cyclical prices, is what it the appropriate amount of net debt to carry on the balance sheet? According to EY (2017a), low gearing ratios, defined as net debt as a percentage of shareholders equity, provides mining companies the opportunity to survive weak commodity prices, and the opportunity to have the financial means to respond to investment opportunities as and when they arise. On the other hand, an appropriate amount of debt allows companies to allocate a greater portion of capital to growth opportunities and potentially achieve higher production volume growth rates (EY, 2017a).

EY (2017b) indicated that the debt gearing ratios for the top 50 mining companies in the world by market capitalisation peaked at approximately 42% in 2015. According to EY (2017b), the gearing ratios have been declining since 2015 due to higher amount of capital allocated to repayment of debt. In this step the debt gearing ratios and net cash flow to net debt ratios were determined for each company. The levels of the debt gearing ratio in relation to prevailing basket commodity price provided key indicators of mining companies' capital allocation strategy.

3.2.7 Step 7 – Review of debt used to finance capital allocations

In this step the levels of debt used in the finance of capital allocations and its impact on gearing ratios were analysed.

3.2.8 Step 8 – Review of capital impairments

One of the key indicators in the relative success of a capital allocation decision is the amount of capital that has been impaired. According to the International Accounting Standards Number 36 (IAS 36), an impairment loss is incurred when the value of an asset on the company's balance sheet is greater than the recoverable value of the asset (EY, 2010). According to EY (2010), the value of the impairment loss is equal to the difference between the value of an asset on the balance sheet and the recoverable value of the asset. An example listed by EY (2010) on the recoverable value of a mine in production is the net present value of the future net cash flows generated over the life of mine. If the net present value is lower than the value carried on the balance sheet then an impairment loss is incurred. In this step the total amount of impairments for the five mining companies over the period from 2001 to 2017 were analysed.

3.2.9 Step 9 – Calculating the return on capital employed and return on invested capital

The ROIC and ROCE were determined for each of the selected mining companies over a 17 year period from 2001 to 2017. The ROIC and ROCE were compared to the net capital allocated to investment activities as a percentage of the annual operational costs, and the prevailing basket of commodity prices at the time of investment over the analysis period. The purpose of this comparison was to test for any correlation between return on investment and the timing of the capital expenditure in relation to the prevailing basket of commodity prices.

3.3 Empirical test of the research hypothesis

In order to test the research hypothesis that value can be unlocked through allocating capital in a counter cyclical manner relative to the historical commodity price cycle, historical analyses of the select mining companies over the analysis period was done. The analyses aimed at establishing if there is a correlation between return on capital employed, and the timing of capital allocated as a function of the position within the commodity cycle.

Due to the long lead time nature of capital investments in mining, where first production typically lags initial capital investment by several years, it is difficult to draw any meaningful conclusions in comparing ROCE in a particular year against the capital invested in that year. Return on capital invested may only be realised many years after the capital investment was made. To overcome this the ROCE between 2001 to 2017, lagged by between three to seven years, were compared to the timing of the capital allocations. The timing of the capital allocations are presented by an index called the Capital Invested Price Cycle Index (CIPCI). The CIPCI was obtained by multiplying the capital investment as a percentage of the annual operation expenditure with the BCPI. For example the CIPCI value for a diversified mining company with a total annual operational spend of US$2,000 million in the year of measurement, allocating capital of US$500 million in the year of measurement, during which time the BCPI value was 1.1, is calculated using Equation 3.1.

$$CIPCI = BCPI \times \frac{Capital\ invested}{Total\ operational\ expenses} \quad 3.1$$

$$CIPCI = 1.1 \times \frac{500}{2000} = 0.275\ index\ value$$

Where:

Capital invested (CI) = Sum of stay-in-business capital and expansionary capital invested per annum;

Total opex = Total annual operational expenditure in the year of measure; and

BCPI = Basket commodity price index weighted by sales.

The CIPCI has a higher weighting for capital allocation decisions made during historical high commodity prices and a lower weighting during historical lower commodity prices. Mining companies that have counter cyclical capital allocation policies should have a more consistent CIPCI profile. The volatility of the CIPCI over the analysis period from 2001 to 2017 was used as an indicator of the measure of counter-cyclical capital allocation adopted by the mining company.

The steps followed to determine the CIPCI are outlined below:

1. Determine the BCPI values as described in sub-section 3.2.2.
2. Calculate CI values in the year of measure as a percentage of total annual operational expenditure.
3. Calculate CIPCI by multiplying CI with BCPI.

The CIPCI provides a measure of the total capital spend by the mining company in a particular year, in relation to where the prevailing commodity prices are compared to the historic commodity price cycle. Mining companies that typically allocate higher amounts of capital during periods of high commodity prices, and allocate lower amounts of capital during periods of low commodity prices, will have more cyclical CIPCI values, with high CIPCI values during high commodity price periods, and low CIPCI values during low commodity price periods. Conversely, mining companies that follow a more contrarian investment approach will have more consistent CIPCI values throughout the commodity price cycle. In order to test if a linear relationship exists between the CIPCI values and the ROCE and ROIC achieved, scatter diagrams between CIPCI and ROCE, and CIPCI an ROIC were constructed. After confirming the linear relationship between the two data sets from the scatter diagrams, the Pearson's product-moment correlation coefficient (Pearson's correlation coefficient) between the CIPCI values and the ROCE and ROIC respectively were calculated. The rating scale shown in Table 3.1, was used to interpret the Pearson's correlation coefficient and test if a contrarian capital allocation approach has a higher probability of achieving superior investment returns. This method was also used to test if a linear relationship exists between the amount of capital committed and BCPI.

Next, the coefficients of determination, also known as R-squared value, were calculated from the Pearson correlation coefficients. According to Taylor (1990), the coefficient of determination (R^2) is defined as *"the percent of the variation in the values of the dependent variable (y) that can be explained by variations in the value of the independent variable (x)"*. The coefficient of determination was obtained by squaring the Pearson correlation coefficient. The coefficient of determination provides an indication of the influence of the independent variable on the dependent variable.

Table 3.1: Pearson correlation coefficient interpretation

(Source: Onifade and Genc, 2018)

Correlation coefficient value	**Correlation interpretation**
Zero	No linear relationship
0 to 0.1 (0 to -0.1)	Very weak positive / (negative) linear relationship
0.1 to 0.24 (-0.1 to -0.24)	Weak positive / (negative) linear relationship
0.25 to 0.5 (-0.25 to -0.5)	Moderate positive / (negative) linear relationship
0.51 to 0.94 (-0.51 to -0.94)	Strong positive / (negative) linear relationship
0.95 to 1.0 (-0.95 to -1.0)	Perfect positive / (negative) linear relationship

3.4 Chapter summary

This chapter discussed the research method used to determine the historical capital allocation success and the return on investment from the capital allocation decisions made by the selected companies over a 17 year period. Mauboussin and Callahan’s (2014a) framework was used as a guideline in this research study. Nine steps were followed to analyse and determine the success of the capital allocation strategy.

The CIPCI index was developed to consider both the amount of capital invested and the timing of the investment in relation to the prevailing commodity price. Investment done during a high commodity price cycle will have a higher CIPCI, whilst investments completed in a low price environment will have lower CIPCI values. All data for this study was obtained from the companies’ respective annual financial reports that are available in the public domain. The results from the historical capital allocation analysis for Anglo American are provided and discussed in the next chapter.

4 ANALYSIS OF CAPITAL ALLOCATION BY ANGLO AMERICAN

4.1 Chapter overview

In this chapter the results from the research study on Anglo American are presented and analysed. Firstly, an overview of the historical capital allocation decisions made by Anglo American is provided. Next, an overview of the financial performance of Anglo American over the analysis period is provided to determine the impact of historical capital allocation decisions. Next, the correlation between capital commitments made by Anglo American and the prevailing commodity prices are analysed.

The use of debt funding by Anglo American and the impact of this on Anglo American's balance sheet is analysed. A list of impairments incurred by Anglo American over the 17 year period is provided in the chapter. The analysis also include a review of total capital returned to shareholders in the form of dividend payments and share buy-backs. Next, the return on capital employed and return in invested capital were determined in relation to the net capital allocation to investment activities as a percentage of the annual operational costs. Lastly, the hypothesis that the timing of capital investment decisions in relation to the prevailing commodity price has an impact on the overall return on capital employed was tested.

4.2 Historic capital allocation

Anglo American's historical allocation of capital to either building of new assets, purchase of new assets or returning capital to shareholders is provided in Figure 4.1. EBITDA in real 2000 terms is also provided in Figure 4.1. The terms build, buy and return are as defined in sub-section 3.2.1. The data points contained in Figure 4.1 are provided in Appendix 11.1 and Appendix 11.2.

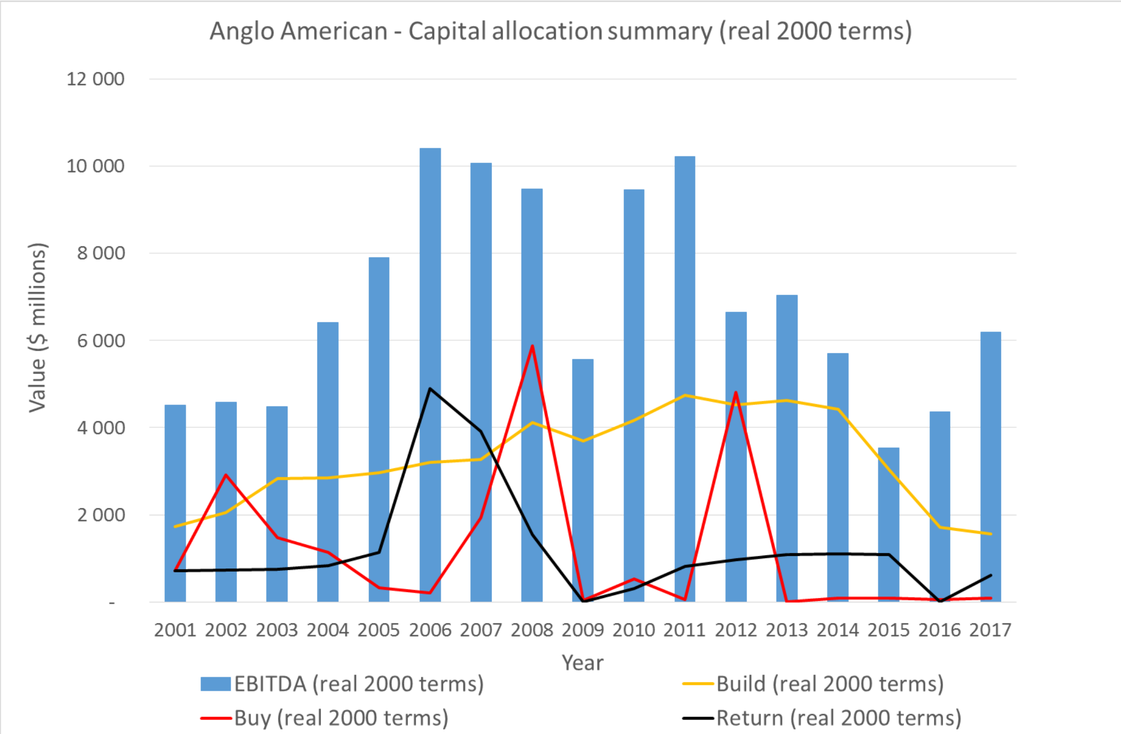

Figure 4.1: Anglo American summary of historical capital allocation for the period 2001 to 2017

Figure 4.1 indicates that Anglo American allocated significantly more capital to build compared to buying and returning capital to shareholders. Capital allocation to expansion projects and stay-in-business projects increased progressively from 2001 to 2013, after which it reduced in-line with the reduction in commodity prices. Figure 4.1 indicates significant increases in acquisitions in 2008 and 2012, which were due to a US$5.1 billion acquisition of the remaining minorities in Anglo Ferrous Brazil in 2008, and the acquisition of an additional 40% shareholding in De Beers in 2012. The major capital allocation decisions made by Anglo American over the analysis period are summarised below (Anglo American, 2001 – 2017):

- The increase in the buy graph in 2002 was primarily due to the acquisition of 100% of Disputada, a Chilean copper producer at a purchase price of US$1,380 million;

- In 2006 there was a significant increase capital returned to shareholders in the form of dividends and share buy-backs. This was made possible due to strong EBITDA from operations as indicated in Figure 4.1.
- The year 2007 was a watershed year for Anglo American with a number of acquisitions and disposals, of which the most significant acquisition was the 49% interest purchased in the MMX Minas-Rio iron ore project in Brazil for US$1,208 million. Minas-Rio phase 1 was estimated to cost US$3,460 million and would produce 26.5 million tonnes of iron ore. During 2007 a number of major projects were approved with a combined value of approximately US$7 billion. Of these the largest were the Los Bronces expansion for US$1,700 million and Phase 1 Minas Rio iron ore project for US$3,456 million;
- In 2008 the remaining minorities in Anglo Ferrous Brazil was acquired for a total cost of US$5.3 billion, which is the primary reason for the significant increase in the buy graph in 2008. Anglo American continued with the development its major projects with a total capital spend of US$17 billion, a US$5 billion increase over 2007;
- The dramatic decrease in the buy and return graphs in 2009 was in response to the financial economic crises;
- In 2011 and 2012 the amount of capital allocated to build increased to all-time highs. The increase was in response to high commodity prices. The capital allocated to build in 2011 and 2012 included the five million tonnes per annum (mtpa) Grosvenor metallurgical coal project in Australia and the Collahuashi Phase Two copper expansion project in Chile. The significant increase in the buy graph in 2012 was due to acquisition of an additional 40% shareholding in De Beers, which was completed in 2012. Notably in 2012 a number of delays and capital cost increases in the Minas-Rio project were announced which resulted in a write-down of US$4 billion in the carrying value of the asset. In 2012 the estimated capital cost of the Minas Rio project was increased from the initial approved US$3.5 billion to an expected US$8.8 billion;

- A more stringent capital allocation model was followed by Anglo American since 2013, when the investment philosophy changed from a previous focus on volume growth to a primary focus on quality and return on investment within the commodity portfolio believed to provide the most attractive future returns. This can be seen in the build graph in Figure 4.1, where there was a systematic decrease buy graph from 2014 to 2017;
- In 2014 a number of assets in the platinum, copper and coal businesses were identified for potential sale;
- During 2015 disposal transactions to the value of US$2.1 billion were concluded. The disposals included the sale of Anglo Platinum's Rustenburg operations and the Norte operation in the copper division; and
- During 2016 a number of disposals were concluded which include, the niobium and phosphate business in Brazil for US$1.5 billion, a 9.7% interest in Exxaro Resources, and the Callide and Foxleigh coal mines in Australia.

The major capital allocation decisions made by Anglo American over the analysis period indicate a strong focus on allocating capital to growth projects during periods of relatively high commodity prices from 2005 to 2008, and 2011 to 2012. This is contrast to the period of declining commodity prices from 2013 to 2016 where the focus changed to disposal of non-core assets, and reduction of debt. Figure 4.2 shows capital allocation as a percentage of revenue relative to the basket commodity price index to demonstrate the relationship between the prevailing commodity prices on the allocation of capital. The data points contained in Figure 4.2 are provided in Appendix 11.1.

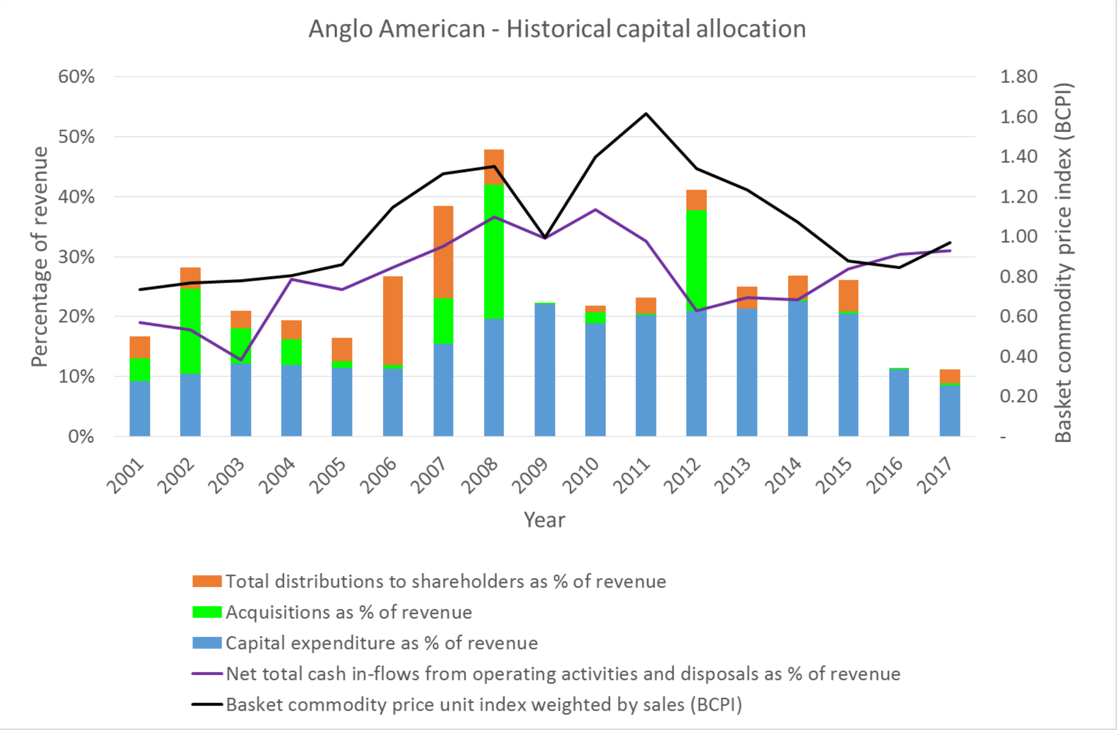

Figure 4.2: Anglo American historical capital allocation in relation to the prevailing commodity prices

During times of relatively high commodity prices, total capital outflows significantly exceeds total cash inflows in 2007, 2008, and 2012. The only exception is 2002, where the basket commodity price realised was relatively weak. The higher capital outflows were primarily driven by strategic acquisitions made in those years as outlined in the paragraphs above. These periods of high capital investments were typically followed by a couple of years of lower capital investment to allow for the repayment of debt and reduction of the net gearing ratio.

Anglo American have made a number of disposals during the four year period between 2013 and 2017, reducing the number of operational assets from 68 assets in 2013 to 36 assets at the end of 2017 (Anglo American, 2017). This is contrast to the period between 2005 and 2012, when significant number of acquisitions and major project approvals were announced. The reduction in number of operational assets during the four year period between 2013 and 2017, was as result of a new strategic plan led by Mark Cutifani, Anglo American's CEO who replaced Cynthia Carrol on 3 April 2013. As part of the new strategic plan all operational assets aimed to deliver a ROCE of 15%, and assets not capable of meeting this criteria were considered for disposal (Anglo American, 2013).

4.3 Overview of historical financial performance

The relative success of historical capital allocation decisions are reflected in the financial performance of Anglo American over the analysis period as shown in Figure 4.3, where the total revenue, total capital expenditure, total operating costs and EBITDA are provided in real 2000 terms. The nominal values were de-escalated to real 2000 terms by using the United States of America consumer price index (USA CPI). The data points contained in Figure 4.3 are provided in Appendix 11.1 and Appendix 11.2.

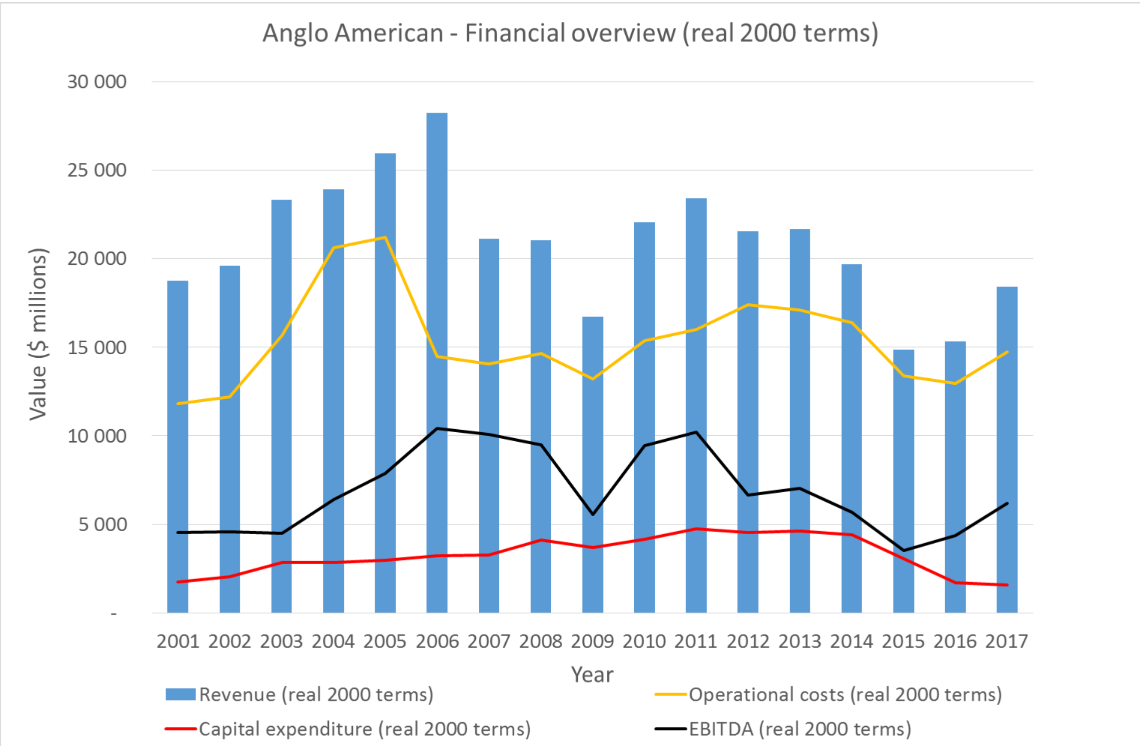

Figure 4.3: Financial overview of Anglo American for the period 2001 to 2017

Figure 4.3 indicates that revenues per annum were cyclical ranging between US$15 billion and US$25 billion per annum, with a typical 7 year period between cycle troughs. This increase and decrease in revenue was primarily due the increases and decreases in commodity prices. Operational costs remained relatively constant around US$15 billion in real 2000 terms. EBITDA varied between US$5 billion to US$10 billion per annum, whilst capital expenditure gradually increased in real terms from 2001 to 2014. Notably, there was a progressive year-on-year reduction in total capital expenditure and progressive year-on-year increase in EBITDA in the last three years. One of the conclusions from Figure 4.3 is that notwithstanding a steady increase in capital expenditure, Anglo American was not able to achieve sustainable above inflation increases in EBITDA over the analysis period.

4.4 Revenue and production volume growth

The impact of capital allocation on revenue and production volume growth is shown in Figure 4.4 which indicates Anglo American's revenue derived from commodities produced over the analysis period. The revenue values were calculated by multiplying the production volume with the respective average annual commodity price of the commodity produced. The calculated revenues may differ slightly from the published annual revenues which typically include other special accounting items not included in this revenue calculation. The revenue was adjusted to real 2000 terms using USA CPI inflation. The data points contained in Figure 4.4 are provided in Appendix 11.4 to Appendix 11.8.

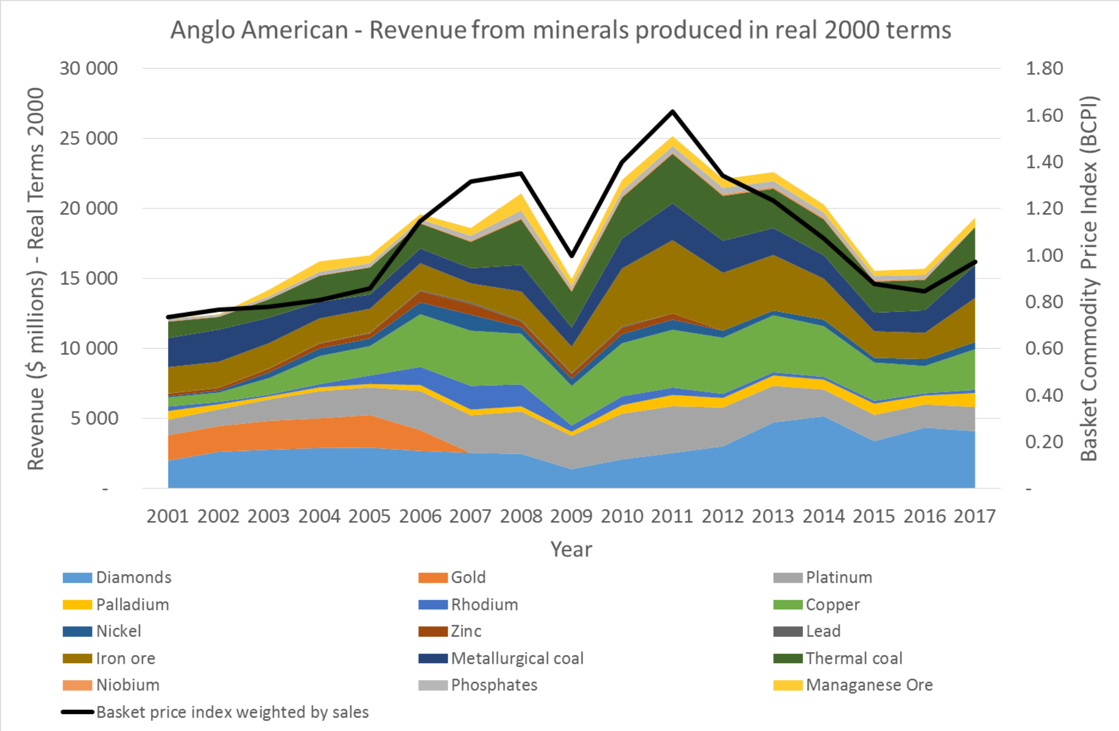

Figure 4.4: Anglo American revenue derived from mineral production in real 2000 terms

Anglo American's revenue make-up indicates a well-diversified mix of commodities with a relatively even distribution of revenue contributions between the various commodities. The maximum revenue contribution from a single commodity was equal to less than 25% of the overall sales which is a good indication of the well diversified production mix of Anglo American. The divestment in gold in 2006 and zinc in 2011 can also be seen in Figure 4.4. Figure 4.4 also indicates a strong positive linear relationship between total revenue and BCPI with a Pearson correlation coefficient of 0.91. The divergence between total revenue and the basket price index during 2012 to 2017 is an indication of production volume growth at the operations.

Table 4.1 provides the percentage revenue split between commodities produced by Anglo American in the periods 2001, 2008, 2011 and 2017. The years 2008 and 2011 are included as they represent the peaks of the commodity price cycles.

Table 4.2: Anglo American revenue split by commodity produced

Revenue split by commodity produced	**Unit**	**2001**	**2008**	**2011**	**2017**
Diamonds	%	16.5%	11.7%	10.1%	21.2%
Gold	%	14.9%	0.0%	0.0%	0.0%
Platinum	%	9.1%	14.3%	13.3%	8.9%
Palladium	%	5.1%	1.8%	3.2%	5.1%
Rhodium	%	2.6%	7.5%	2.1%	1.2%
Copper	%	5.4%	17.1%	16.4%	15.0%
Nickel	%	0.7%	2.3%	2.9%	2.6%
Zinc	%	1.5%	1.9%	1.8%	0.0%
Lead	%	0.1%	0.4%	0.0%	0.0%
Iron ore	%	15.5%	9.8%	20.8%	16.3%
Metallurgical coal	%	17.1%	9.0%	10.5%	12.2%
Thermal coal	%	9.7%	15.4%	14.0%	14.0%
Niobium	%	0.3%	0.5%	0.5%	0.0%
Phosphates	%	1.1%	2.5%	1.7%	0.0%
Managanese Ore	%	0.2%	5.8%	2.8%	3.4%
Total		**100%**	**100%**	**100%**	**100%**
Number of commodities produced		**15**	**14**	**13**	**10**

Notably, over the 17 year period from 2001 to 2017 Anglo American reduced the number of commodities produced by 33% from 15 products in 2001 to 10 products in 2017. Anglo American became less diversified over the analysis period with a larger dependence on diamonds, platinum group metals (PGM's), copper, iron ore and coal. Notably, in 2013 Anglo American indicated that their future strategic focus will be on iron ore, copper, diamonds and platinum group metals production (Anglo American, 2013). This however changed in recent years following the recovery in coal and nickel prices, with Anglo American deciding against the disposal of the coal and nickel operations (Anglo American, 2017). Figure 4.5 shows the growth in production volumes relative to the production volumes achieved in the year 2000.

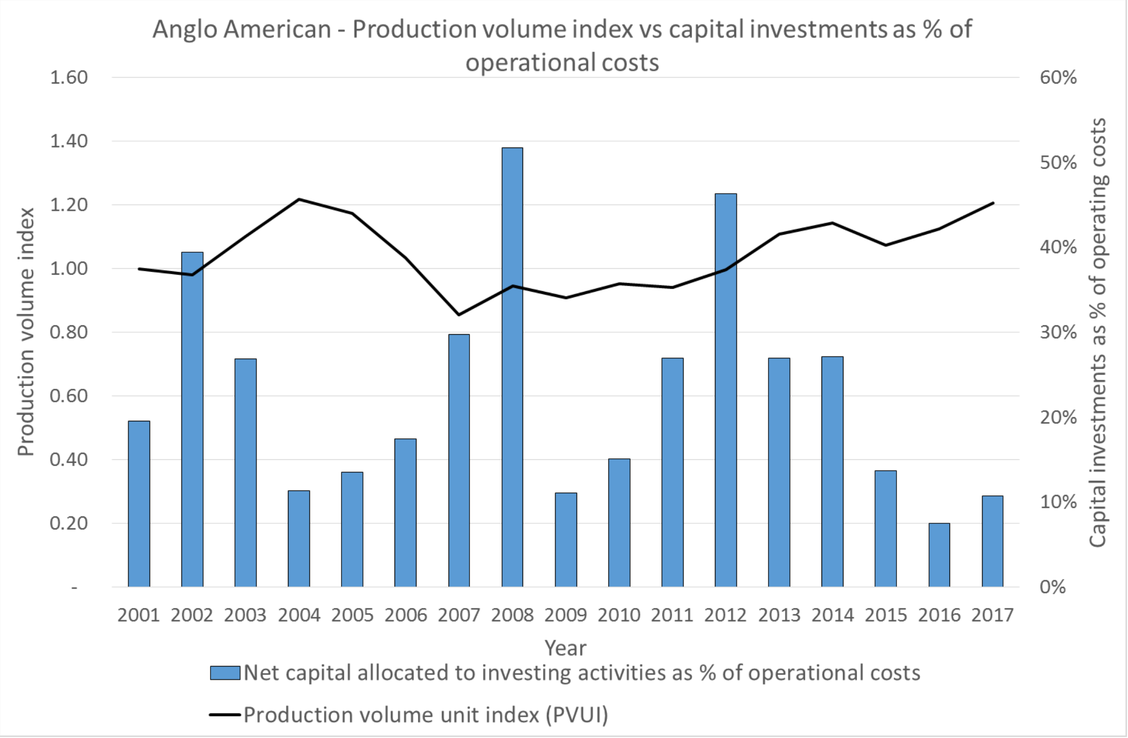

Figure 4.5: Anglo American production volume growth index

Over the 17 year analysis period the production volume index progressively increased by 21% which is a compounded annual growth rate (CAGR) of 1.2%. This means that over the analysis period Anglo American achieved very low increases in relative production volumes. On average Anglo American committed capital towards growth activities equal to 23% of the annual operational costs expenditure. Therefore, it can be inferred that Anglo American needs to allocate approximately 20% of operational costs towards capital expenditure in order to sustain production levels.

4.5 Capital commitments and actual capital expenditure

Capital commitments towards stay-in-business (SIB) capital and expansionary capital in real 2000 terms, are indicated in Figure 4.6 relative to the basket commodity price index. Capital commitments is a lead indicator of capital allocation decisions as it eliminates the time delay between capital allocation decision and when actual capital is expensed.

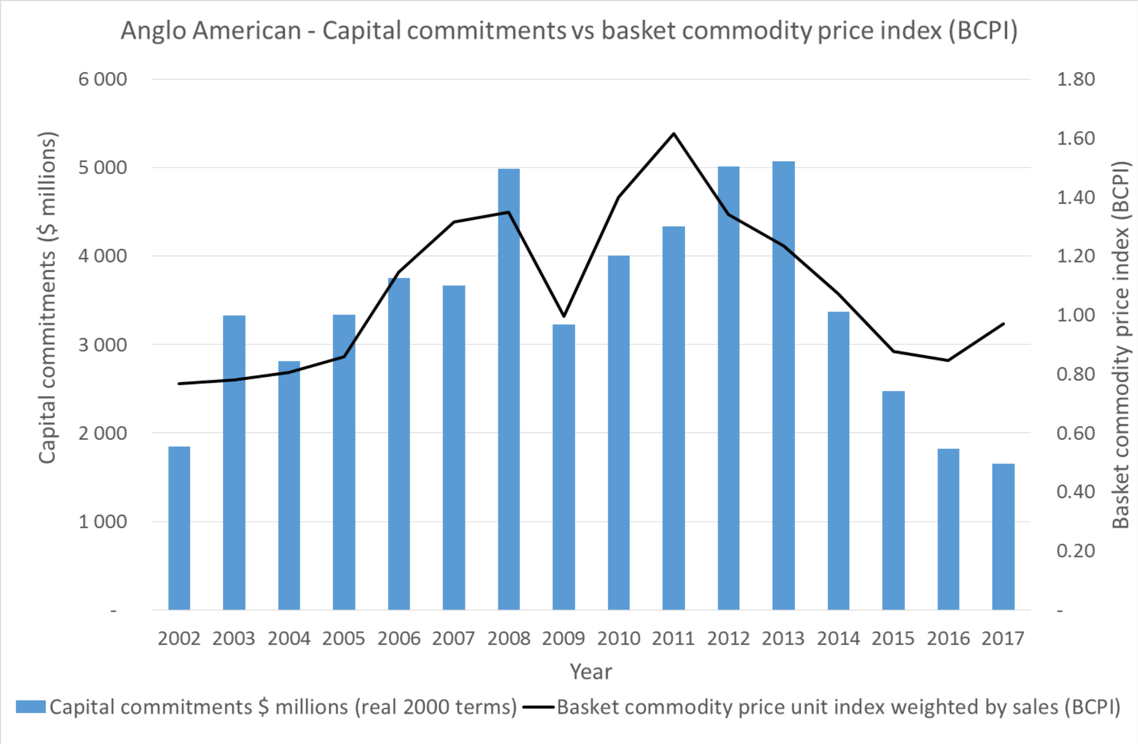

Figure 4.6: Anglo American capital commitments relative to prevailing commodity prices for the period 2001 to 2017

Figure 4.6 indicates a high correlation between the prevailing commodity price and the value of capital commitments, with a typical lag of one year. This indicates that historically Anglo American committed more capital during times of relatively high commodity prices. In Figure 4.7 the linear relationship between the capital commitments and the prevailing commodity prices is represented in a scatter diagram.

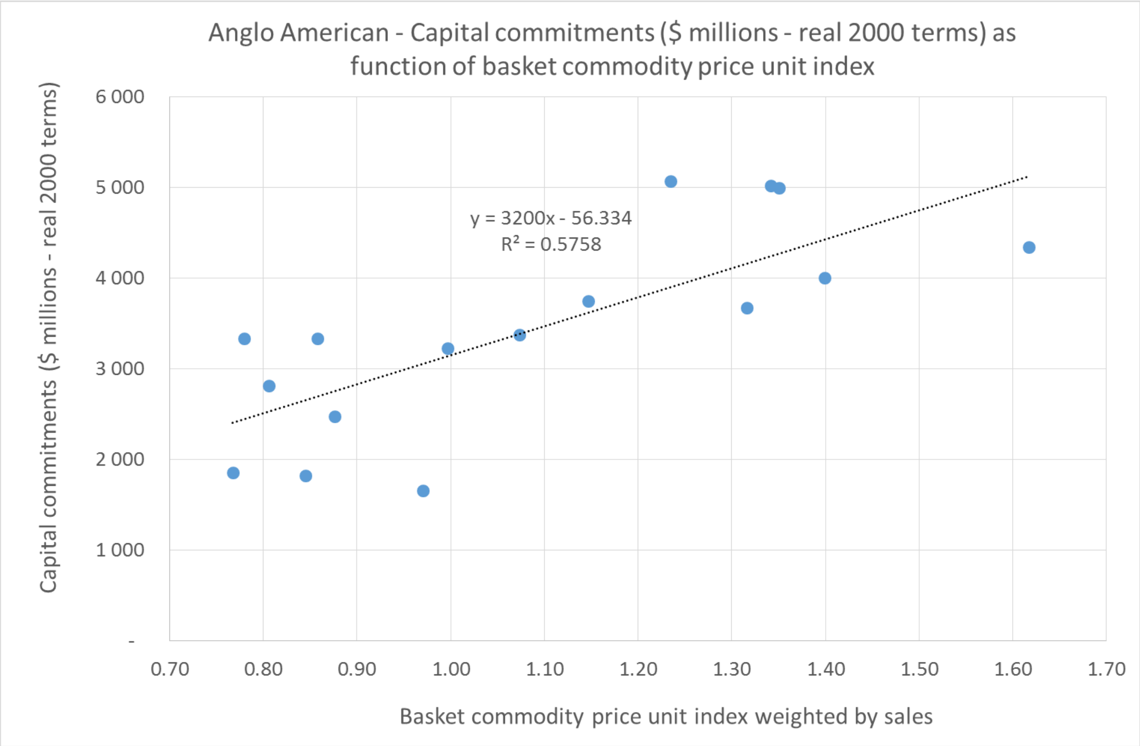

Figure 4.7: Anglo American - scatter diagram of capital commitments relative to prevailing commodity prices for the period 2001 to 2017

Figure 4.7 indicates a strong positive linear relationship between capital commitments and the prevailing basket commodity prices. The coefficient of determination (R^2) is 0.58, which means that 58% of the variations in the amount of capital allocated can be explained by variations in the prevailing basket commodity prices index. The Pearson correlation coefficient between the basket commodity price index and the value of capital commitments is 0.76, indicating a strong positive linear relationship.

Actual capital expenditure as a percentage of operational expenditure is a good indication of the amount of investment that is directed to sustain or increase production levels. Comparing capital expenditure against operational expenditure takes into account the actual escalation cost in the mining industry as both capital expenditure and operational expenditure are typically exposed to the same escalation factors. The actual capital expenditures as percentage of operational costs are indicated in Figure 4.8.

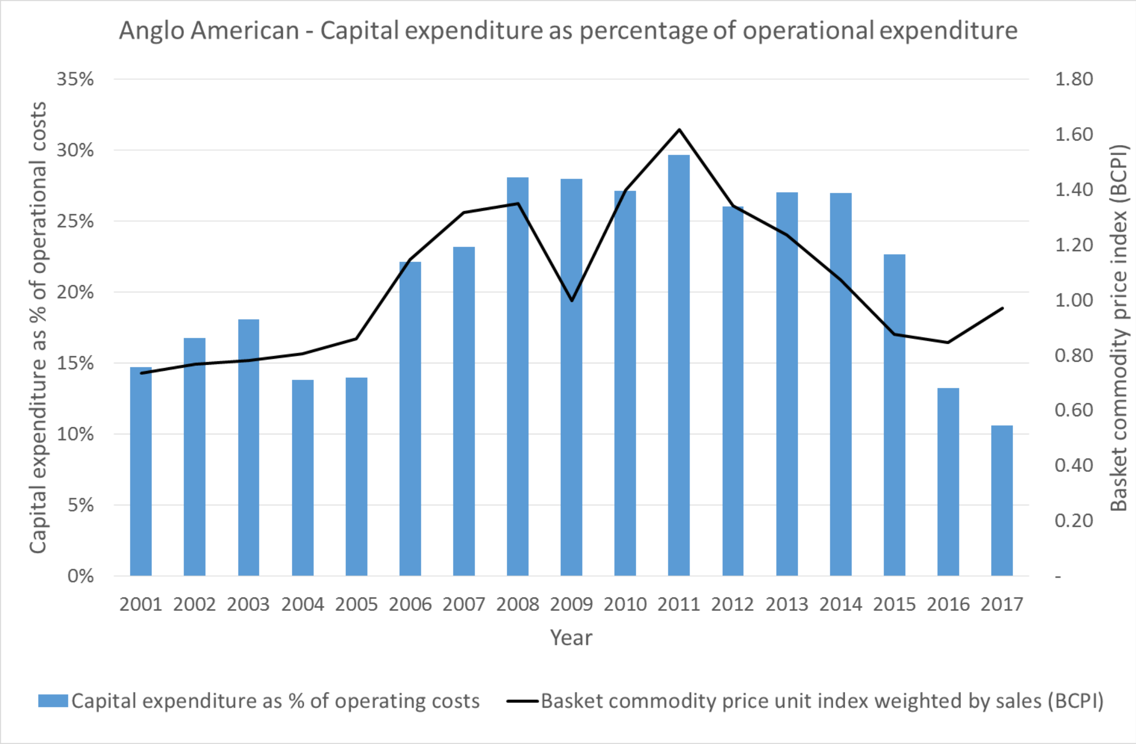

Figure 4.8: Anglo American capital expenditure as percentage of operational costs for the period 2001 to 2017

Figure 4.8 indicates a strong positive correlation between capital expenditure as a percentage of operational costs and the prevailing basket commodity price. This correlation has a Pearson coefficient of 0.72 which indicates a strong positive linear relationship between capital costs as percentage of operational costs and the basket commodity price index. The strong correlation indicates that Anglo American allocated more capital during periods of high commodity prices.

4.6 Distributions to shareholders

Figure 4.9 indicates the total distribution of capital to shareholders, which includes both dividends and share buy-backs, as a percentage of total revenue versus the basket commodity price index.

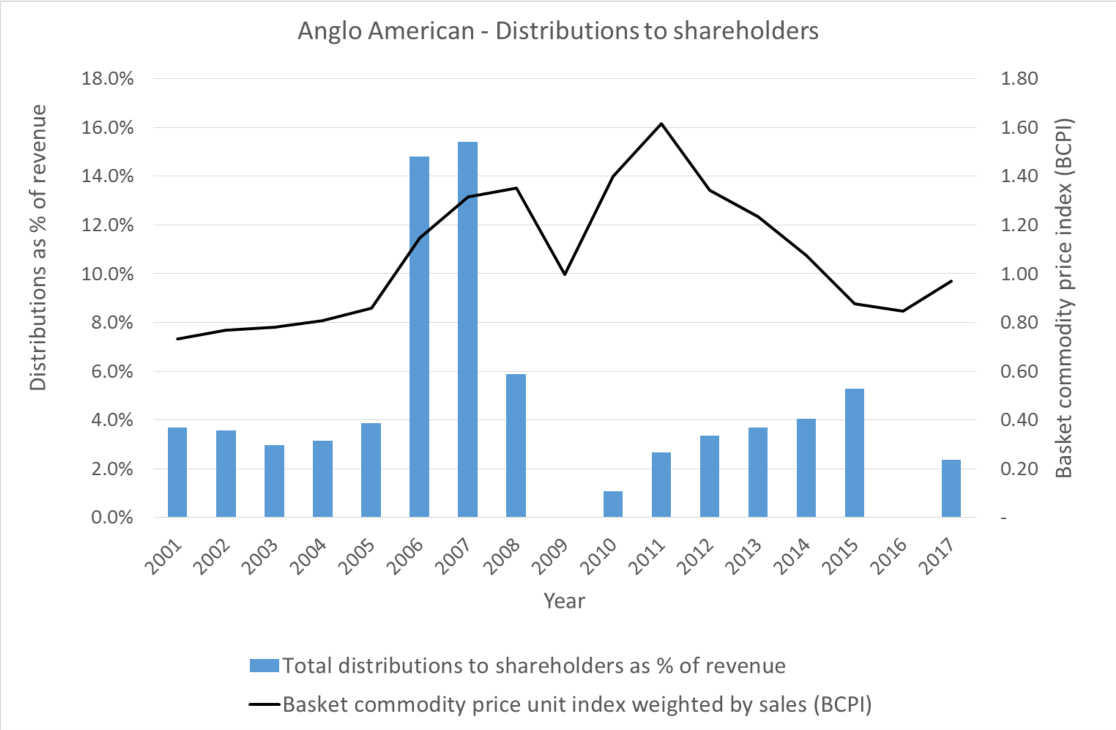

Figure 4.9: Anglo American distributions to shareholders for the period 2001 to 2017

During 2001 to 2005, distributions to shareholders as a percentage of revenue were reasonably constant between three and four per cent. This was in response to relatively weak commodity prices. During the subsequent periods of higher commodity prices in 2006 to 2008 distributions increased dramatically to an average of 12% of revenue. In 2009 and 2016 distributions to shareholders were nil in response to the low commodity prices in those years. Notably from 2012 to 2015 there was a progressive increase distributions to shareholders as a percentage of revenue, notwithstanding a progressive decrease in commodity prices. This can be ascribed to a change in executive management in 2013 and change in capital allocation strategy where the focus changed from growth to return on capital employed (Anglo American, 2013).

4.7 Balance sheet strength

An overview of the strength of Anglo American's balance sheet is provided in Figure 4.10 where the net debt to net cash flow ratio, defined as the coverage ratio, and net gearing ratio over the analysis period are shown. The coverage ratio provides an indication of the company's ability to repay net debt from operational cash flows.

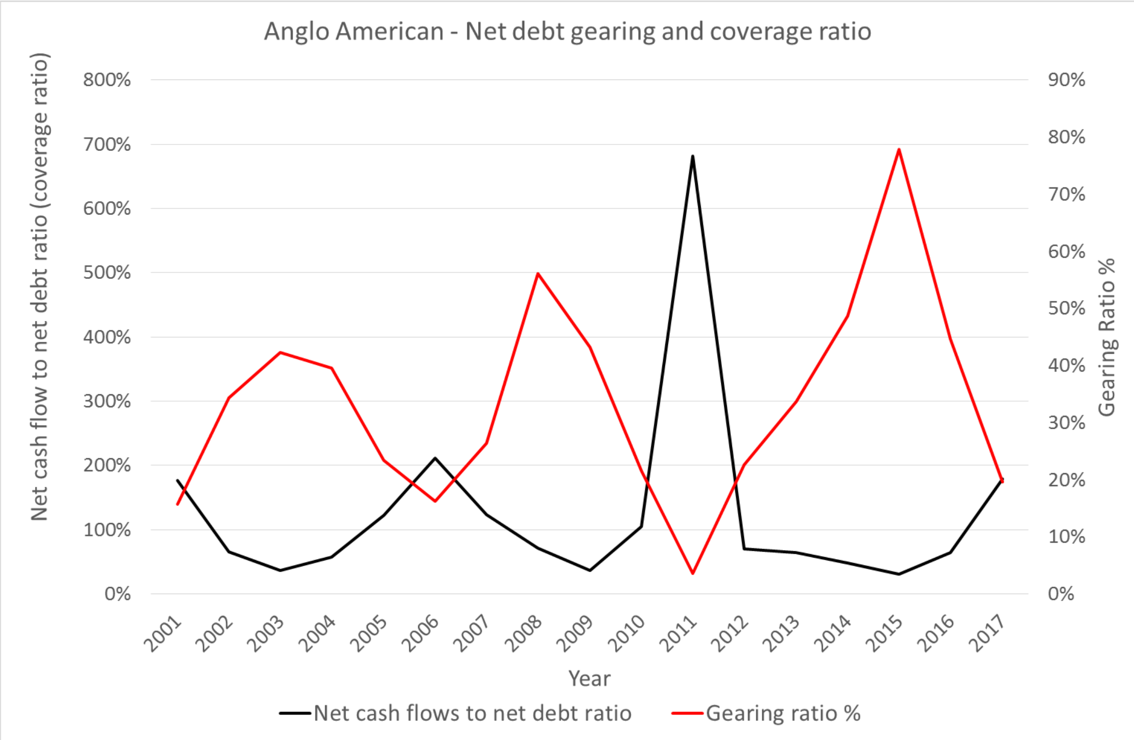

Figure 4.10: Anglo American net cash flows to net debt ratios

Historically, the average coverage ratio for Anglo American over the analysis period was 126% ranging between a low of 31% in 2015 and a high of 681% in 2011. The peak in coverage ratio in 2011 was due to very strong operational cash generation from operations. The strong operational performance was due to high commodity price in 2011. As shown in Figure 4.2 total capital outflows remained high in 2012, 2013 and 2014 which led to increase in the gearing ratio and a reduction in the coverage ratio. The high capital outflows in 2012, 2013 and 2014 were due to high capital expenditure at Minas Rio iron ore project, and the acquisition of 40% shareholding in De Beers in 2012.

4.8 Use of debt to finance capital commitments

The split between investments and repayment of debt is provided in Figure 4.11.

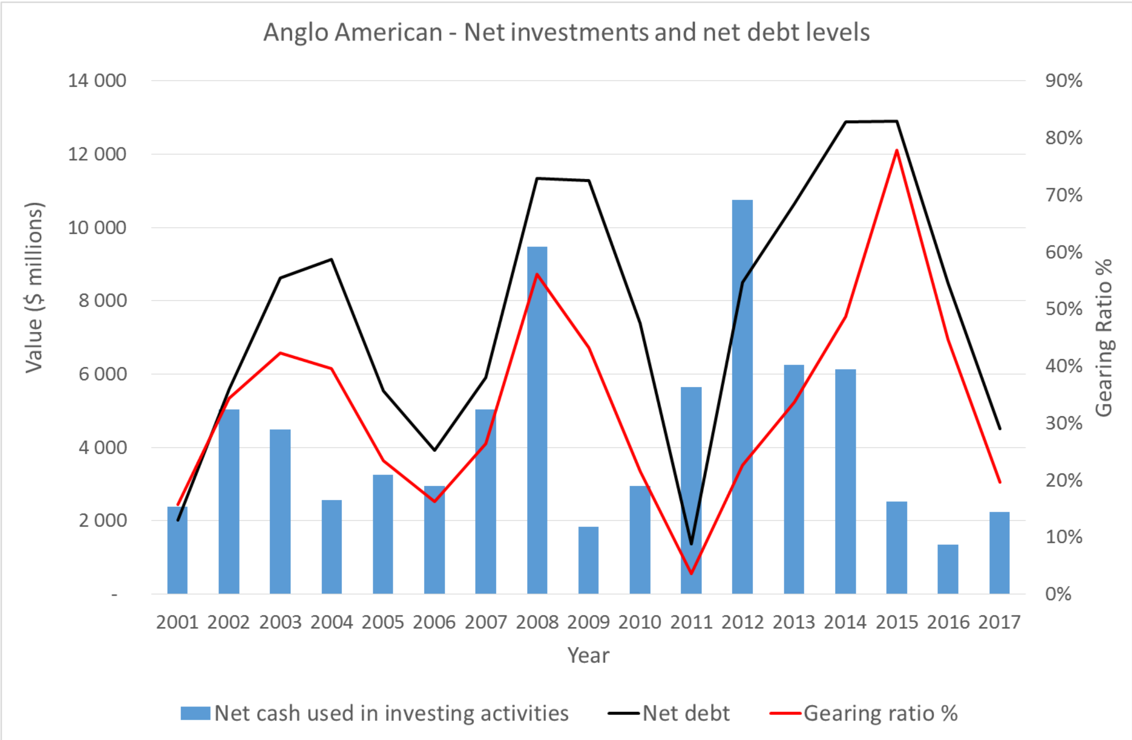

Figure 4.11: Anglo American net investments and net debt levels for the period 2001 to 2017

Figure 4.11 indicates a positive correlation between capital investment values and net debt levels. Based on this correlation it can be assumed that Anglo American made use of debt funding as one of the financing tools to fund its capital investments. During periods of significant capital investments Anglo American's gearing ratio increased above 50%.

4.9 Impairments

Impairments relative to the basket commodity price unit index is shown in Figure 4.12. Figure 4.12 also indicates net cash flows from acquisitions and disposals. In Figure 4.12 positive cash flows indicate that the value of total disposals in the year exceeded the total cost of acquisitions, and vice versa.

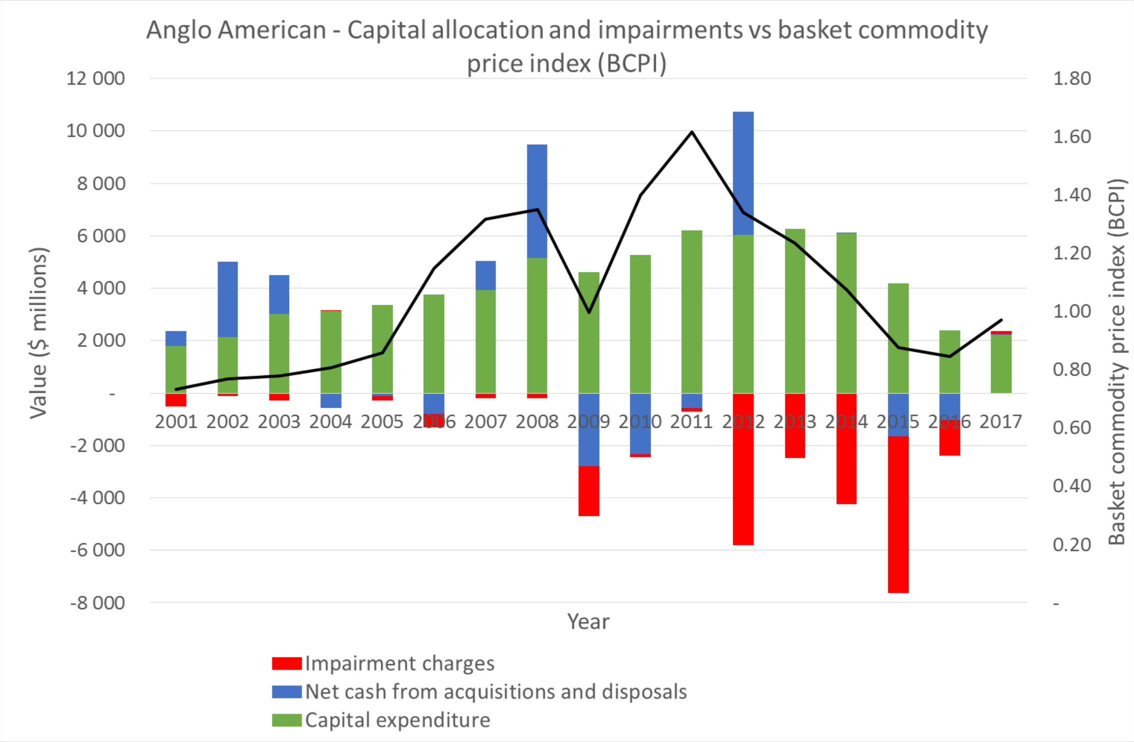

Figure 4.12: Anglo American historical capital allocation and impairments for the period 2001 to 2017

Notably, significant capital was allocated to acquisitions in 2008 and 2012 which coincide with high commodity prices. In 2008 Minas Rio was acquired, and in 2012 an additional 40% shareholding in De Beers was acquired. Conversely, significant disposals and impairments were made during relative weak commodity prices. In the declining commodity price environment from 2012 to 2016 significant impairments of a total of US$19.9 billion were announced. Table 4.2 provides a breakdown of the total capital allocated and total impairments over the analysis period.

Table 4.3: Total net investments by Anglo American during 2001 to 2017

Description	Unit	Value	% of total net investment
Total net investment from 2001 to 2017	**$ millions**	**74 819**	**100%**
Total capital expenditure from 2001 to 2017	$ millions	69 532	93%
Total acquisitions from 2001 to 2017	$ millions	20 295	27%
Total disposals from 2001 to 2017	$ millions	-15 008	-20%
Total impairments from 2001 to 2017	$ millions	-23 919	-32%

Table 4.2 indicates that of the total US$74.8 billion invested over the analysis period, total impairments of US$23.9 billion were made which represents 32% of the invested capital.

4.10 Return on capital employed

ROCE relative to the net capital investment and the prevailing commodity prices are shown in Figure 4.13. The data points contained in Figure 4.13 are provided in Appendix 11.3.

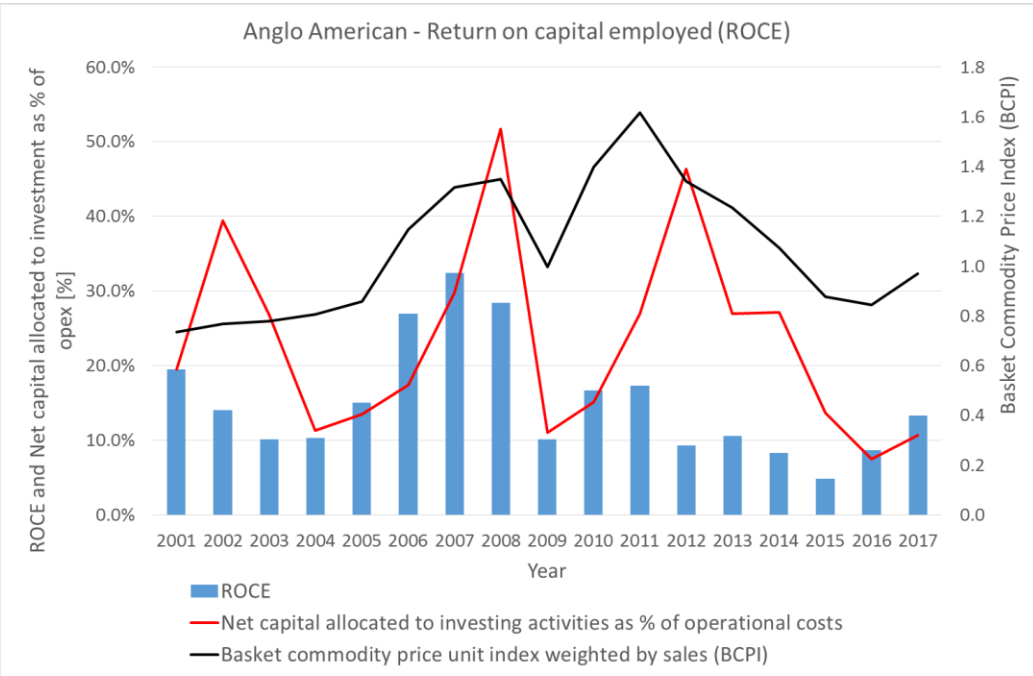

Figure 4.13: Anglo American return on capital employed for the period 2001 to 2017

ROCE shows a moderate positive linear relationship with the prevailing commodity prices of commodities produced over the period with a Pearson correlation coefficient of 0.49. This indicates that Anglo American typically allocated larger amounts of capital to investment activities during periods of high commodity prices. There is a moderate positive linear relationship between the net capital allocated to investment activities and ROCE with a Pearson correlation coefficient of 0.33. This low positive correlation is likely due to the positive price correlation that the prevailing commodity price had with both ROCE and the net amount of capital invested. Figure 4.14 shows ROIC relative to net capital investments and the prevailing basket commodity price.

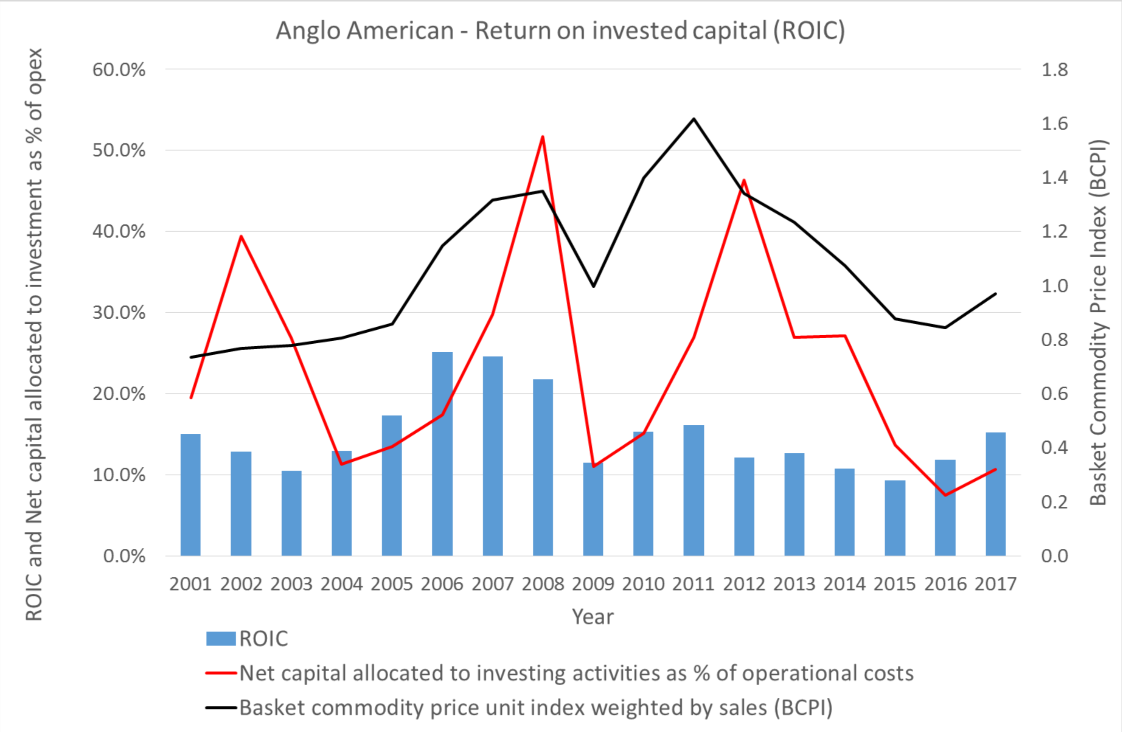

Figure 4.14: Anglo American ROIC for the period 2001 to 2017

The Pearson correlation coefficient between ROIC and the basket commodity price index is 0.52. This strong positive linear relationship is expected as the commodity prices have a large influence of revenue and return on capital employed. Similar to the results obtained for ROCE, there is little if any correlation between the capital allocated to investment activities and ROIC with a Pearson correlation coefficient of 0.20. This indicates that the amount of capital allocated to investment activities had little influence on the return on capital obtained.

4.11 Hypothesis test

Figure 4.15 indicates ROIC relative to CIPCI. Figure 4.15 aims to test the hypothesis that timing of capital allocation decisions in relation to the prevailing commodity prices has an influence on the returns realised on the capital expenditure.

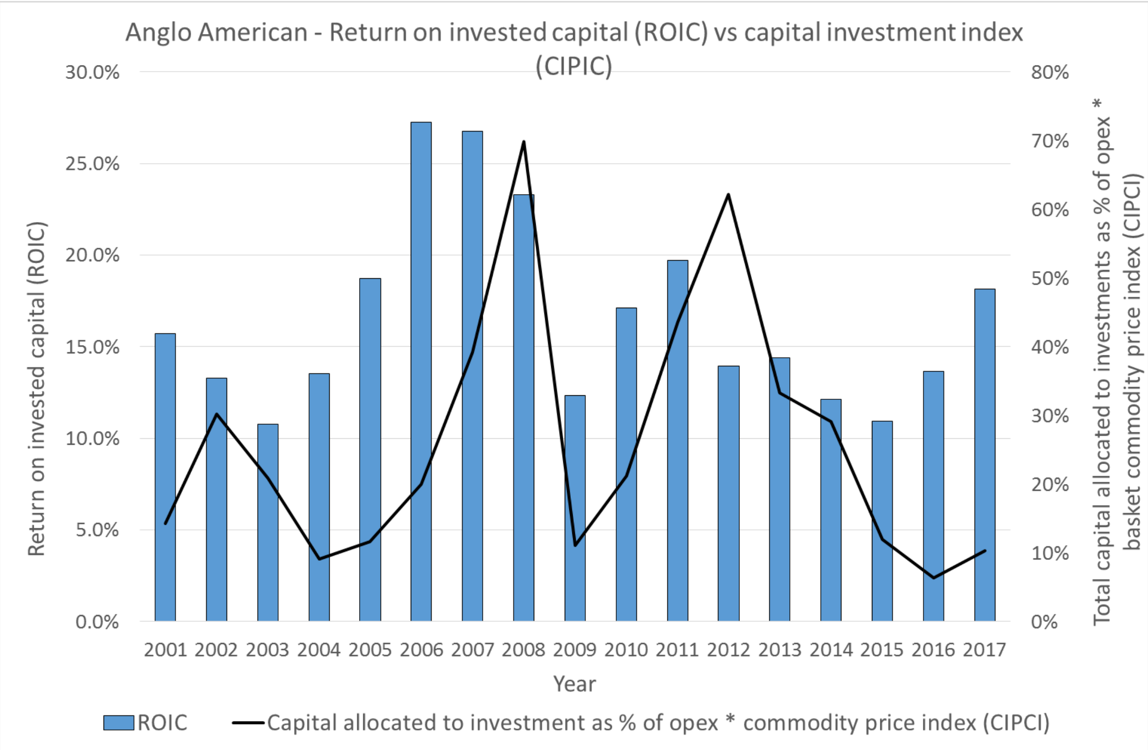

Figure 4.15: Anglo American ROIC as a function of CIPCI for the period 2001 to 2017

Figure 4.15 indicates a cyclical ROIC and CIPCI index cycle, where the ROIC cycle seems to lead the CIPIC index by three years. The time lag between the two cycles could be due to the time duration between when mining capital investments were made and when return on investments were realised. Figure 4.15 also indicates high variability in CIPCI index which indicates that typically

Anglo American did not follow a contrarian investment approach where capital expenditures are increased during periods of lower commodity prices. In order to test the linear relationship between ROIC and CIPCI a scatter diagram was developed for ROIC and CIPIC as shown in Figure 4.16.

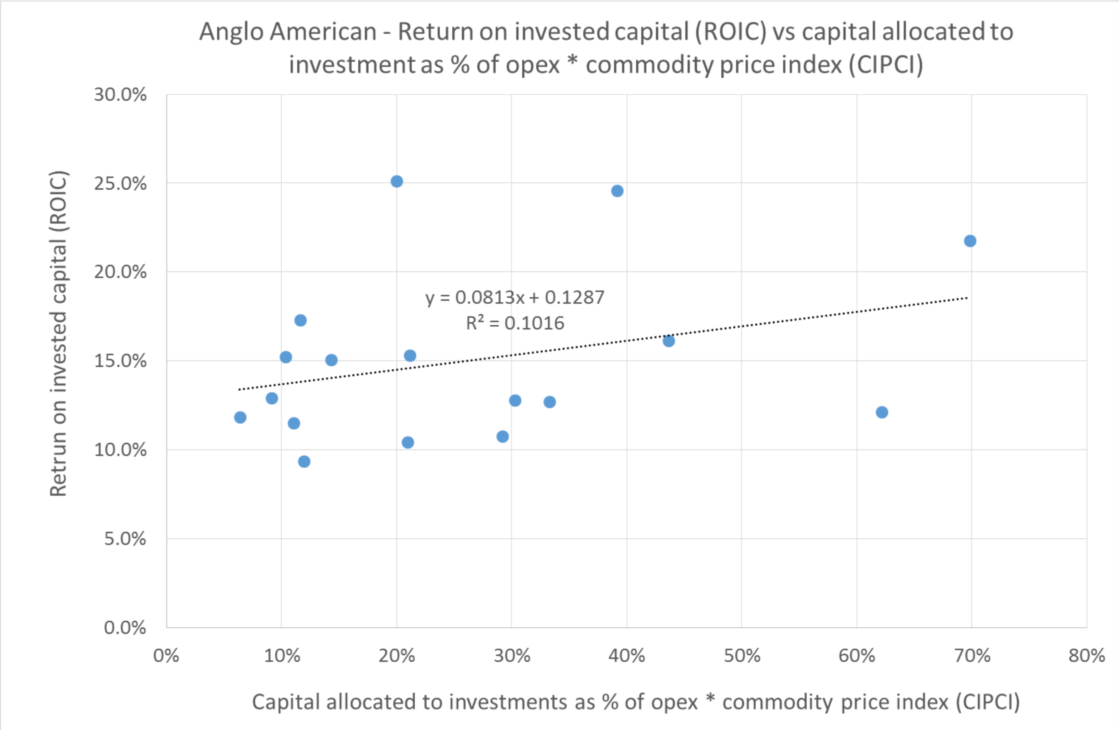

Figure 4.16: Anglo American - scatter diagram of ROIC and CIPCI for the period 2001 to 2017

Figure 4.16 indicates a moderate positive linear relationship between ROIC and CIPCI. The coefficient of determination (R^2) is 0.10, which means that only 10% of the variations in ROIC can be explained by variations in CIPCI. The Pearson correlation coefficient between the basket commodity price index and the value of capital commitments is 0.32, indicating a moderate positive linear relationship. Figure 4.17 indicates ROCE relative to CIPCI. A scatter diagram was used to test the linear relationship between ROCE and CIPCI as shown in Figure 4.18.

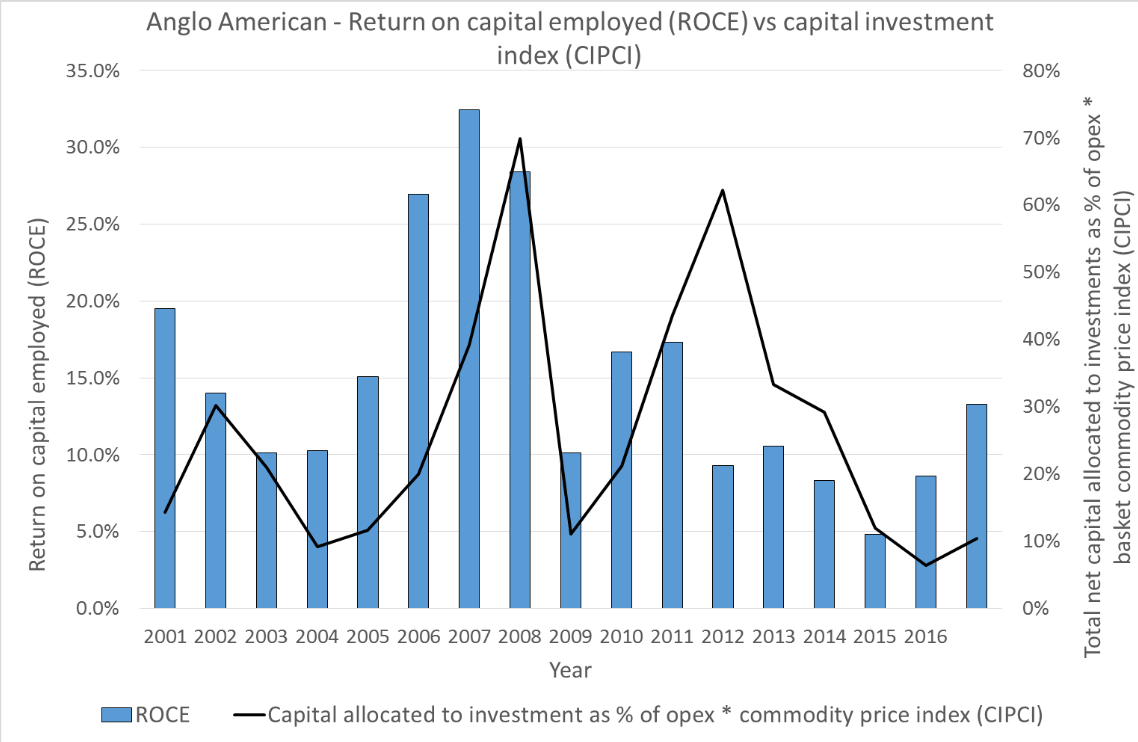

Figure 4.17: Anglo American ROCE as a function of CIPCI for the period 2001 to 2017

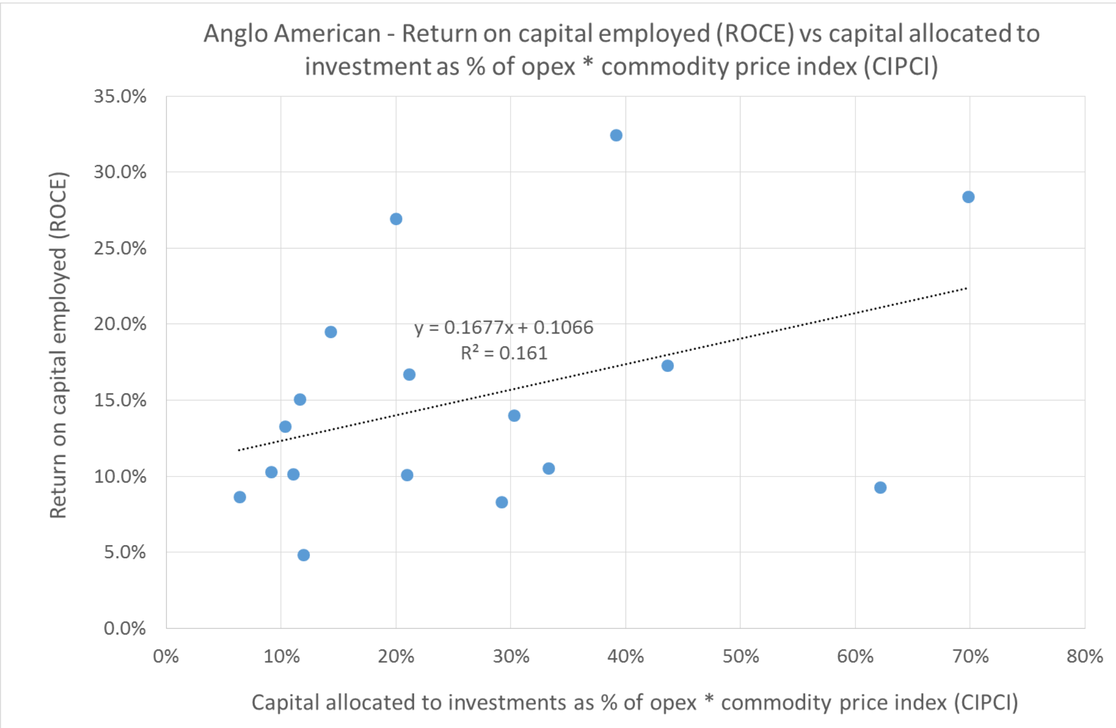

Figure 4.18: Anglo American - scatter diagram of ROCE and CIPCI for the period 2001 to 2017

Figure 4.18 indicates a moderate positive linear relationship between ROCE and CIPCI. The coefficient of determination (R^2) is 0.16, which means that 16% of the variations in ROCE can be explained by variations in CIPCI. The Pearson correlation coefficient between the basket commodity price index and the value of capital commitments is 0.40, indicating a moderate positive linear relationship.

Due to the long lead nature of capital projects in the mining industry, the return on capital employed will typically lag the capital investment date by a couple of years depending on the design and structure of the mine. The impact of the delay period between the date of capital investment and generating a return on capital employed was tested by lagging the ROCE returns by three years to demonstrate the relationship between ROCE and capital investments. In Figure 4.19 the relationship is demonstrated between CIPCI and ROCE achieved three years after the capital investment. Similarly, a scatter diagram was used to test the linear relationship between ROCE lagged by 3 years and CIPCI as shown in Figure 4.20.

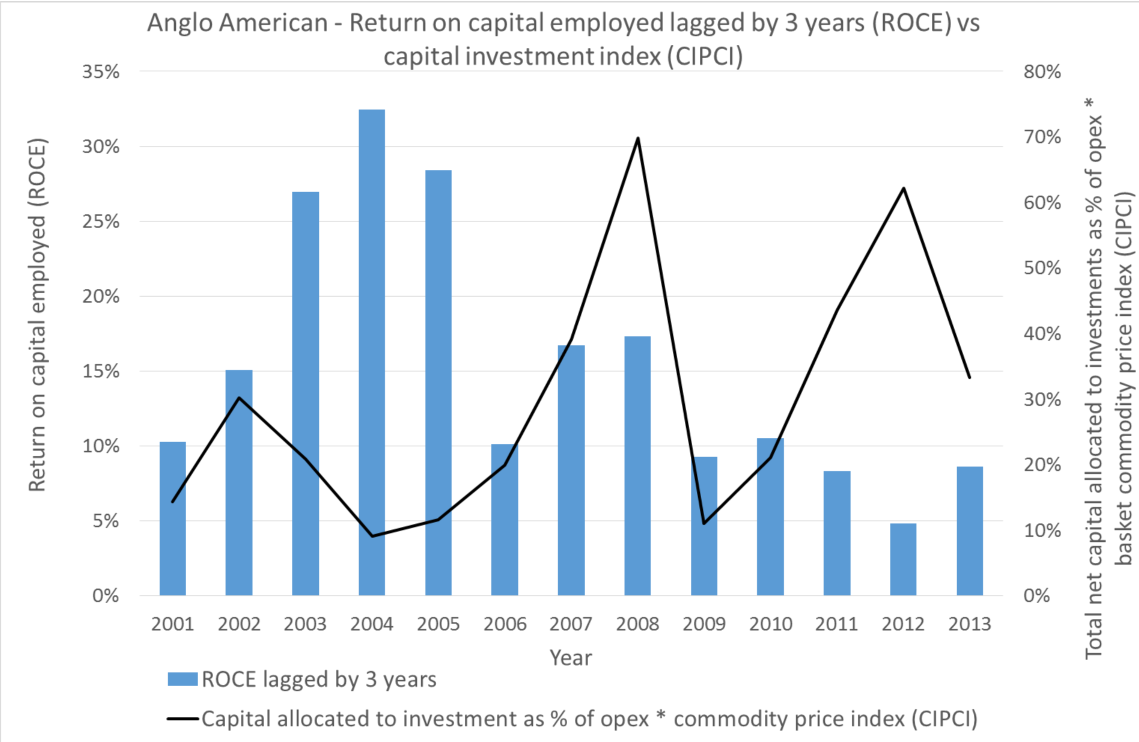

Figure 4.19: Anglo American ROCE lagged by three years as a function of CIPCI for the period 2001 to 2017

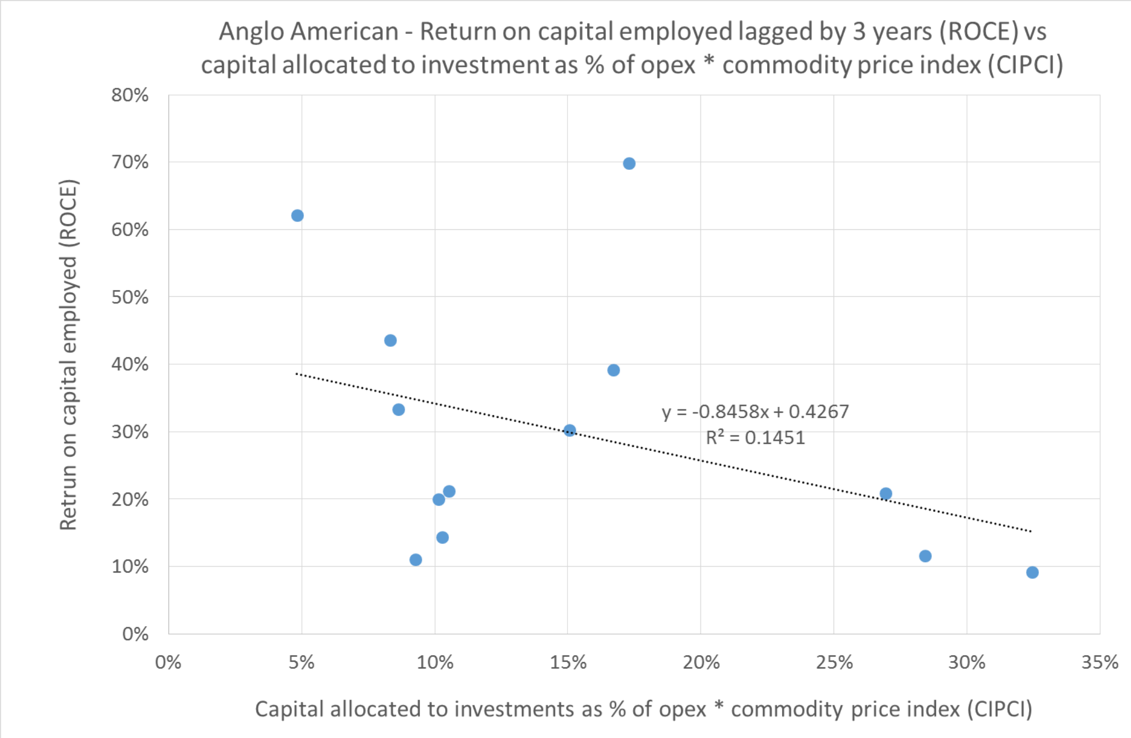

Figure 4.20: Anglo American - scatter diagram of ROCE lagged by 3 years and CIPCI for the period 2001 to 2017

Figure 4.20 indicates a moderate negative linear relationship between ROCE lagged by three years and CIPCI. The coefficient of determination (R^2) is 0.15, which means that 15% of the variations in ROCE lagged by 3 years can be explained by variations in CIPCI. A Pearson correlation coefficient of -0.38 was obtained when the capital investment in a particular year, was compared to the ROCE achieved three years after the capital investment. The moderate negative linear relationship between CIPCI and ROCE lagged by three years indicates that capital investments during periods of high commodity prices have a higher probability of lower ROCE, and vice versa.

4.12 Chapter summary

During high commodity prices in relation to historical prices, from 2005 to 2008, and 2011 to 2012, Anglo American's strategic focus was on increasing production volume growth. The emphasis on growth contributed to an increase in the value of acquisitions and expansion capital expenditure during these periods. Notably, the focus on growth did not translate into an increase in earnings, as Anglo American's EBITDA increased by a small amount in real terms over the analysis period.

In a declining commodity price environment, from 2013 to 2016, Anglo American's strategic focus changed to achieving higher returns on capital employed and returning capital to shareholders. The increased focus on total shareholder returns, led to a reduction in capital allocated to expansionary capital expenditure and acquisitions. In addition Anglo American made a significant number of disposals during the five year period from 2013 to 2017, reducing the number of operational assets from 68 assets in 2013 to 36 assets at the end of 2017 (Anglo American, 2017). This is in contrast to the period between 2005 and 2012, when significant number of acquisitions and major project approvals were announced.

There is a high correlation between the prevailing commodity price and value of capital commitments, with a typical lag of one year. This indicates that historically Anglo American committed more capital during times of relatively high commodity prices. The Pearson correlation coefficient between the basket commodity price index and the value of capital commitments is 0.76, which indicates a strong positive linear relationship.

Figure 4.20 indicates a moderate negative correlation between CIPCI and the ROCE achieved on capital invested three years after the investment is made. Therefore capital expenditure during periods of high commodity prices in relation to the historic average, typically had a lower ROCE three years after the investment was made. The results from the historical capital allocation analysis for BHP are provided and discussed in the next chapter.

5 ANALYSIS OF CAPITAL ALLOCATION BY BHP

5.1 Chapter overview

In this chapter the results from the research study on BHP are presented and analysed. The analysis of BHP followed the same process as the analysis conducted on Anglo American as provided in Chapter 4.

5.2 Historical capital allocation

BHP's historical allocation of capital to either building of new assets, purchase of new assets or returning capital to shareholders are provided in Figure 5.1. The terms build, buy and return are as defined in sub-section 3.2.1. The data points contained in Figure 5.1 are provided in Appendix 11.9 and Appendix 11.10.

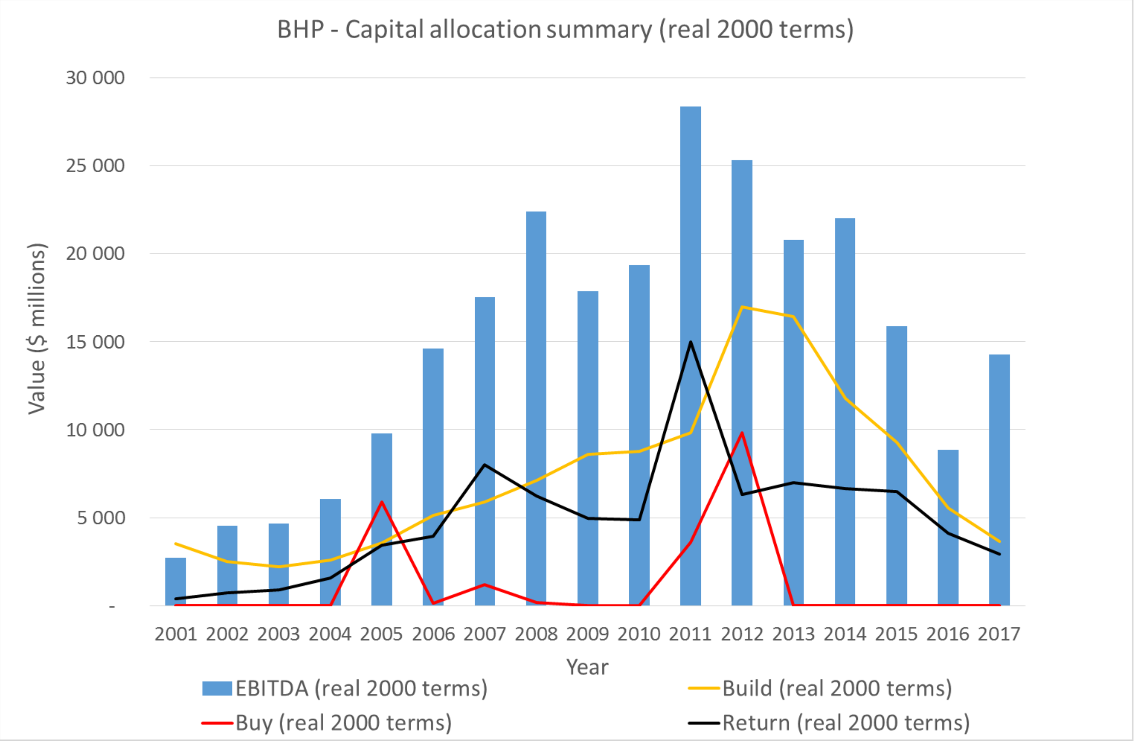

Figure 5.1: BHP summary of historical capital allocation for the period 2001 to 2017

Similar to Anglo American, Figure 5.1 indicates that BHP allocated significantly more capital to building new assets and stay-in business capital compared to buying new assets. Notably, BHP was successful in progressively increasing the amount of capital returned to shareholders between 2001 and 2011. After 2012 the amount of capital returned to shareholders progressively decreased due to the decrease in commodity prices. Similarly, as indicated in the build graph, capital allocation to expansion projects and stay-in-business projects increased progressively from 2001 to 2012, after which it reduced due to declining commodity prices. The major capital allocation decisions made by BHP over the analysis period are summarised below (BHP, 2001 to 2017):

- The progressive increase in the build graph in Figure 5.1 from 2004 to 2012 is due to a number of new projects announced from 2004 to 2008. The long-lead nature of capital projects meant that actual capital expenditure on these project continued well past the global financial crisis in 2008 and 2009. In 2004 new projects with a total value of US$2.2 billion were approved. These projects included Escondida Sulphide Leach Project, development of the Ravensthorpe nickel mine in Australia and further expansion of iron ore mines in Western Australia to a total production capacity of 110 million tonnes per annum;
- The increase in the buy graph in 2005 is due to the acquisition of WMC Resource Limited for US$7.2 billion in 2005. WMC was a diversified Australian mining group that produced copper, nickel, uranium and fertiliser;
- Seven major growth projects we approved in 2006 with a total combined value of over US$5.0 billion. These projects include three petroleum projects namely Shenzi, Stybarrow and NWS Angel project. In addition the Samarco and Rapid Growth Project 3 iron ore projects, Koala diamond project, and Alumar Refinery Expansion project were all approved;
- The increase in the return graph in 2006 and 2007 is due to a US$3.0 billion share buy-back scheme announced in 2006, and a further US$10 billion increase announced in 2007. From 2008 to 2010 there was a

progressive decrease in the amount of capital returned to shareholders in response to the global financial crisis and declining commodity prices;

- In February 2008 an offer was made to acquire the entire ordinary share capital of Rio Tinto Limited, on the basis of one Rio Tinto share for 3.4 BHP shares. The offer was not successful and is thus not reflected in the buy graph in Figure 5.1;
- The dramatic increase in the return graph in 2011 was due to the approval of a share buy-back programme of US$6.0 billion in 2011;
- The build graph indicates that capital allocation to building new mines peaked in 2012 and progressively decreased thereafter. The peak in the build graph is due to a number of expansion projects approved in 2011 and 2012, of which the largest was the approval of the expansion of BHP's iron ore operations in Western Australia with a total cost of US$6.6 billion. In addition an investment of US$2.1 billion into the development of the Caval Ridge coal project in Central Australia was approved in 2012;
- The progressive increase in the buy graph in 2011 and 2012 is due to the acquisition of Chesapeake Energy Corporation's interests in the Fayetteville Shale Project located in the United States of America for a total price of US$4.75 billion;
- In 2013 the amount of capital allocated to build was still relatively high due to an investment of US$2.6 billion approved for the construction of production and service shafts at the Jansen potash project;
- Notably, in response to the declining commodity prices BHP announced a number of disposals in 2013 which included the following:
    - ➢ Disposal of 20 per cent interest in the West Browse Joint Venture and 8.33 per cent interest in the East Browse Joint Venture to PetroChina International Investment (Australia) Pty Ltd for a total amount of US$1.7 billion;
    - ➢ Disposal of BHP's 37.76 per cent interest in Richard Bay Minerals to Rio Tinto for a total amount of US$1.7 billion;

- During 2014 a decision was made to spin-off BHP's aluminium, coal, manganese, nickel and silver operations into a separate listed entity named South32; and
- During 2016 impairment charge of US$7.2 billion was raised against BHP's on-shore US petroleum operations. The impairment is mostly due to a drop in international oil prices.

Figure 5.2 shows capital allocation relative to the basket commodity price index and net cash flows from operating activities. Capital allocation shown in Figure 5.2 is further sub-divided into total dividends paid and share-buy-backs, SIB capital expenditure, expansion capital expenditure, and net cash flow from acquisitions and disposals. The data points contained in Figure 5.2 are provided in Appendix 11.9 and Appendix 11.10.

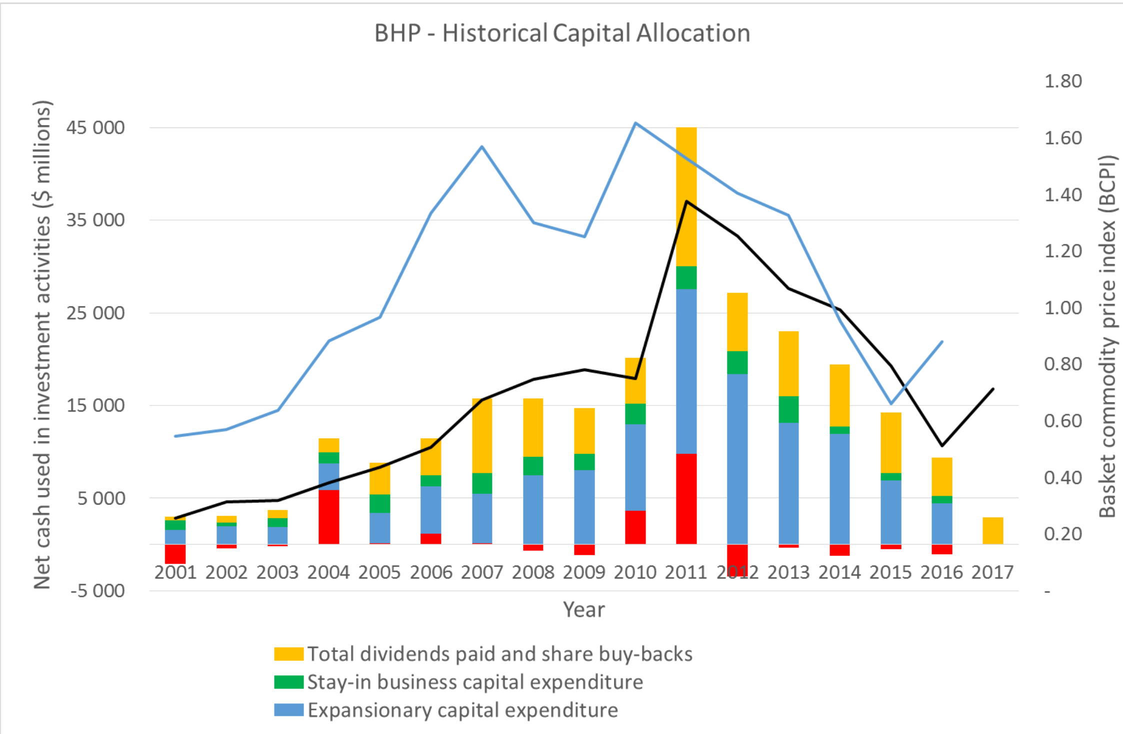

Figure 5.2: BHP summary of historical capital allocation for the period 2001 to 2017

Figure 5.2 indicates that during times of relatively high commodity prices, total capital outflows exceeded total cash inflows in 2004, 2006, 2010, and 2011. In these years of higher capital outflows compared to cash inflows, the net cash shortfall was funded from other financial sources such as debt (BHP, 2001 – 2017). Notably, in the year 2011 cash outflows significantly exceeded net cash inflows from operating activities. This included a significant net cash out flow from acquisitions and disposals, which indicates that the value of acquisitions significantly exceeded the value of disposals. This was primarily due to the US$4.75 billion acquisition of Chesapeake Energy Corporation's interests in the Fayetteville Shale Project, and a US$6.0 billion share buy-back programme. Notably, Figure 5.2 indicates a strong positive linear relationship between the value of total capital allocation and the basket commodity price unit index, with a Pearson coefficient of 0.75. This indicates that similar to Anglo American, BHP did not follow a contrarian capital allocation strategy, and allocated more capital during periods of high commodity prices.

5.3 Overview of historical financial performance

An overview of the financial performance of BHP over the analysis period is provided in Figure 5.3 in which total revenue, total capital expenditure, total operational expenditure and EBITDA are provided in real 2000 money terms. The data points contained in Figure 5.3 are provided in Appendix 11.9 and Appendix 11.10.

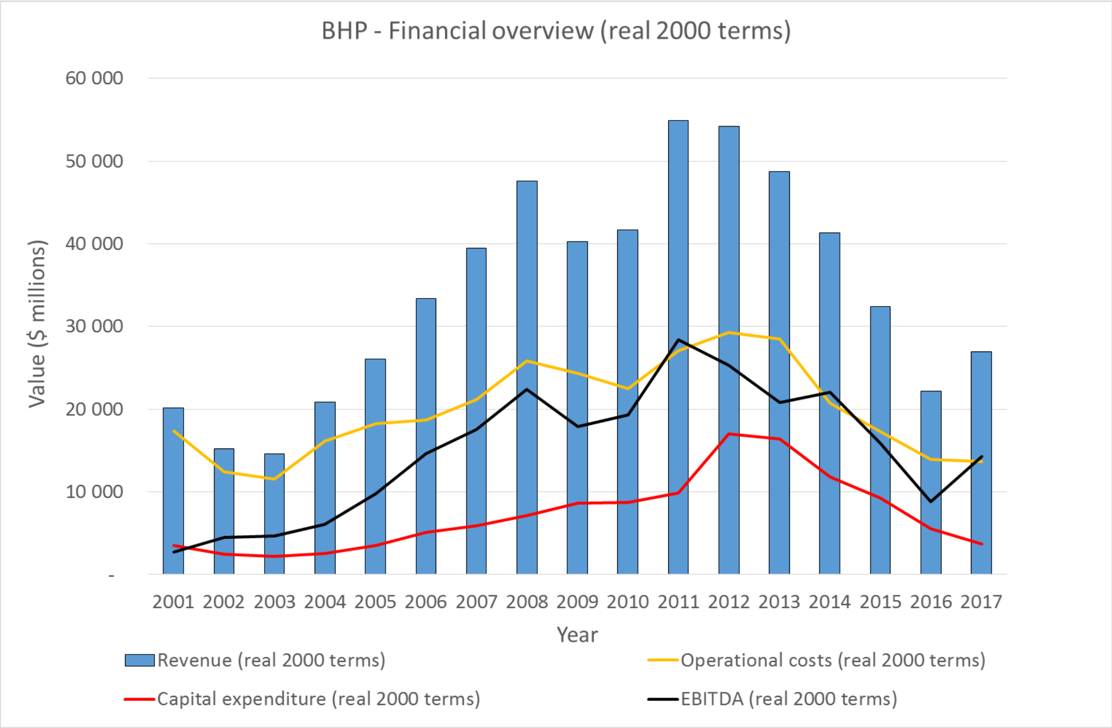

Figure 5.3: Financial overview of BHP for the period 2001 to 2017

Figure 5.3 indicates a positive year-on-year increase in real term revenue between 2001 and 2011 with a positive CAGR of 10.6%. The increases in revenue were due to both production volume and commodity price increases. From 2011 to 2016 revenue decreased by an average negative annual growth rate of -16.6% due to declining commodity prices and disposal of operations. Operational costs increased significantly from US$11.6 billion in 2003 to US$29.3 billion in real 2000 money terms, which is a real terms CAGR of 10.8%. The increases in operational costs were due to increased production levels and above inflation cost escalation. Notably, BHP was successful in reducing operational costs from 2013 to 2017 in response to the declining commodity prices. BHP managed to increase revenue at a faster rate than increases in operational costs, which is evident in the EBITDA increase of 423% in real 2000 terms between 2001 and 2017. Total capital expenditure progressively increased in line with year-on-year increases in revenue during 2001 to 2012, and subsequently decreased from 2012 to 2017.

5.4 Revenue and production volume growth

BHP's revenue in real 2000 terms derived from commodities produced over the analysis period is shown in Figure 5.4. The data points contained in Figure 5.4 are provided in Appendix 11.12 to Appendix 11.16.

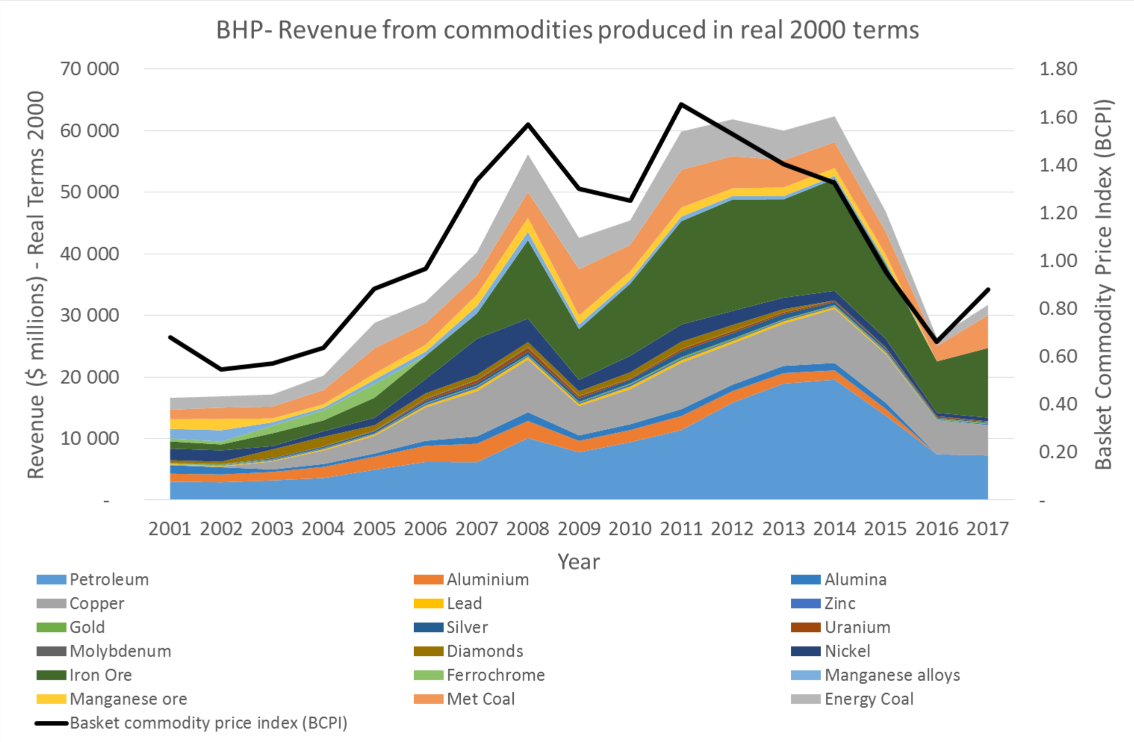

Figure 5.4: BHP's revenue from commodities production in real 2000 terms for the period 2001 to 2017

The revenue indicates a well-diversified mix of commodities with a relative even distribution of revenue split between commodities. Figure 5.4 also indicates a perfect positive linear relationship between total revenue and weighted average basket price index with a Pearson correlation coefficient of 0.96.

Due to a combination of disposals and production volume growth in certain commodities, from 2012 to 2017 BHP became more reliant on a smaller pool of commodities namely, petroleum, copper, iron ore and coal. In 2017 96% of total revenue was derived from these four commodities. This higher reliance on production of a smaller number of commodities left BHP more exposed to commodity price fluctuations of the four commodities. Table 5.1 provides the percentage revenue split between commodities produced by BHP in the years 2002, 2008, 2011 and 2017.

Table 5.1: BHP revenue split by commodity produced

Revenue split by commodity produced	Unit	2001	2008	2011	2017
Petroleum	%	19.2%	18.0%	19.0%	22.9%
Aluminium	%	8.2%	4.9%	3.8%	0.0%
Alumina	%	1.9%	2.5%	1.9%	0.0%
Copper	%	8.9%	15.2%	12.6%	15.5%
Lead	%	0.6%	0.8%	0.7%	0.0%
Zinc	%	0.7%	0.4%	0.4%	0.5%
Gold	%	0.0%	0.2%	0.4%	0.6%
Silver	%	0.9%	0.9%	1.6%	0.4%
Uranium	%	0.1%	1.1%	0.6%	0.3%
Molybdenum	%	0.0%	0.3%	0.1%	0.0%
Diamonds	%	8.2%	1.4%	1.9%	0.0%
Nickel	%	2.7%	6.8%	4.7%	1.9%
Iron Ore	%	12.0%	22.7%	28.0%	35.6%
Ferrochrome	%	7.5%	0.0%	0.0%	0.0%
Manganese alloys	%	3.2%	2.4%	1.3%	0.0%
Manganese ore	%	3.6%	4.0%	2.5%	0.0%
Met Coal	%	9.9%	7.4%	10.2%	16.8%
Energy Coal	%	12.3%	10.9%	10.4%	5.3%
Total	**%**	**100%**	**100%**	**100%**	**100%**
Number of commodities produced		**18**	**17**	**17**	**12**

Notably, over the analysis period BHP reduced the number of commodities produced by 33% from 18 in 2001 to 12 in 2017. This is similar to Anglo American where a similar reduction in commodities produced occurred. Most of the reduction in commodities produced occurred after 2013, following a change in executive management at BHP in 2013 (BHP, 2013). BHP indicated that the change in strategy was in response to the drop in commodity prices from 2012 to 2016 (BHP, 2014). Figure 5.5 shows the growth in production volumes relative to the production volumes achieved in the year 2000.

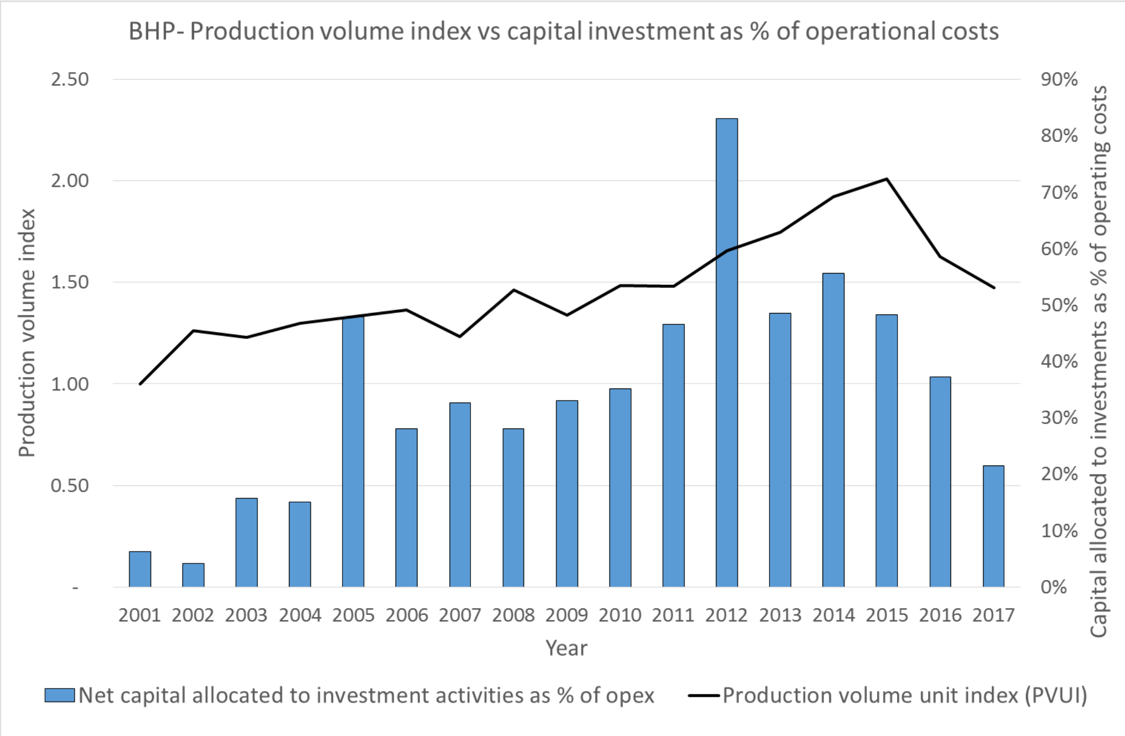

Figure 5.5: BHP production volume growth index for the period 2001 to 2017

Figure 5.5 indicates that over the analysis period BHP's production volume index progressively grew by 47% which is a CAGR of 2.4%. BHP achieved the increase in production volumes by allocating approximately 34% of annual operational costs to growth activities. This is substantially higher than the average of 21% of operational costs that Anglo American allocated to growth activities. Notably, in the period 2014 to 2017 the net capital allocated to growth as a percentage of operational costs declined year-on-year from a high of 56% in 2014 to a low of 21% in 2017. During this period the production volume growth index declined from 1.92 in 2014 to 1.47 in 2017. This drop in capital allocated to growth was in response to a drop in commodity prices (BHP, 2016).

5.5 Capital commitments and actual capital expenditure

Capital commitments towards SIB capital and expansionary capital in real 2000 terms, are indicated in Figure 5.6 relative to the basket commodity price index.

Capital commitments are defined as contractual commitments where purchase orders or contracts have been placed and accrued, but not necessarily expensed.

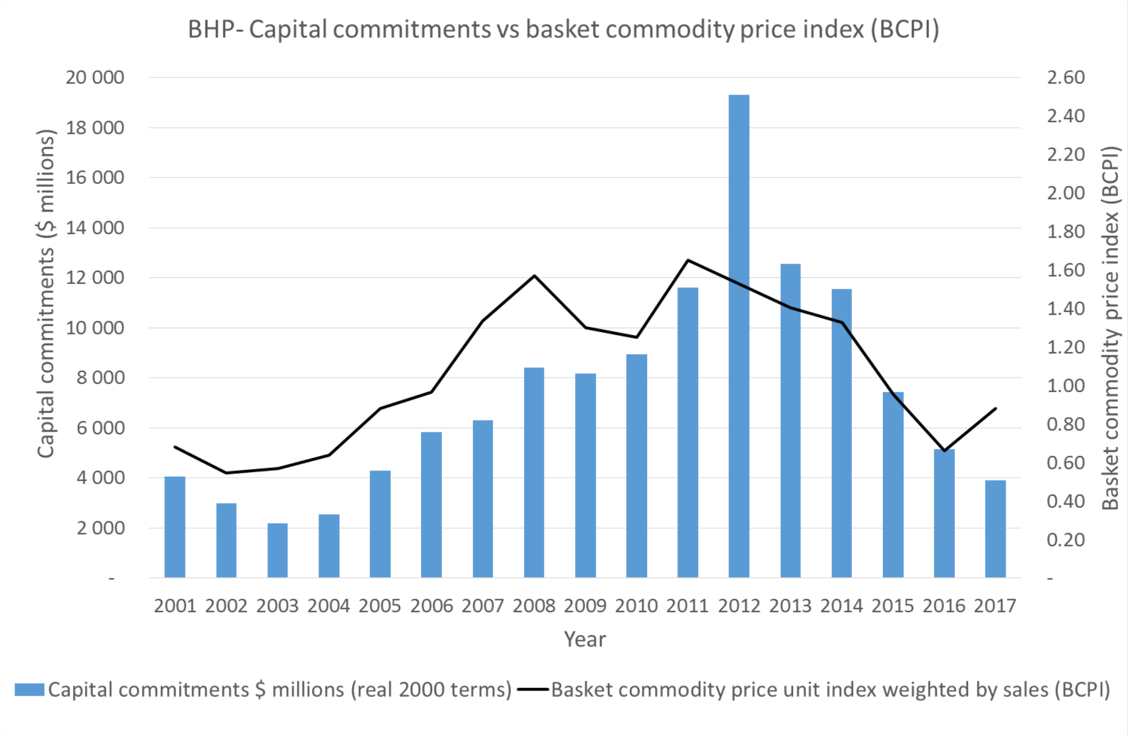

Figure 5.6: BHP capital commitments relative to prevailing commodity prices for the period 2001 to 2017

Figure 5.6 indicates a high correlation between the prevailing commodity price and the value of capital commitments, with a typical lag of one year. This indicates that similar to Anglo American, BHP's management was more inclined to commit capital during periods of relatively high commodity prices. In Figure 5.7 the linear relationship between the capital commitments and the prevailing commodity prices is represented in a scatter diagram.

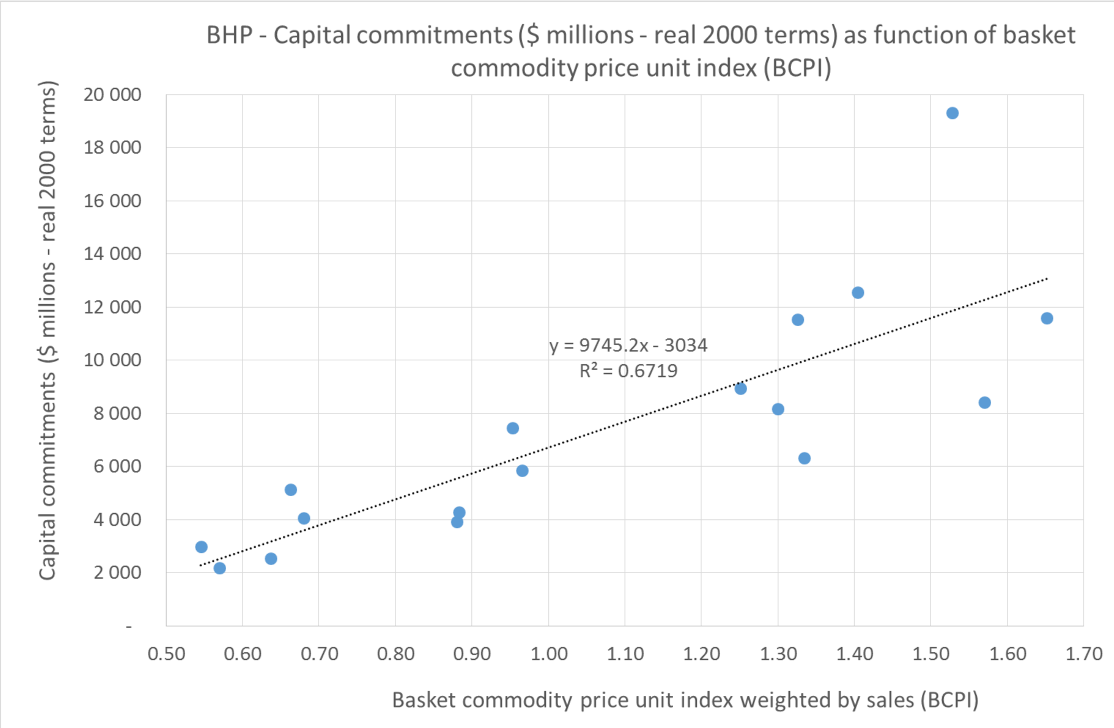

Figure 5.7: BHP - scatter diagram of capital commitments relative to prevailing commodity prices for the period 2001 to 2017

Figure 5.7 indicates a strong positive linear relationship between capital commitments and the prevailing basket commodity prices. The coefficient of determination (R^2) is 0.67, which means that 67% of the variations in the amount of capital allocated can be explained variations in the prevailing basket commodity prices index. The Pearson correlation coefficient between the basket commodity price index and the value of capital commitments is 0.82, indicating a strong positive linear relationship. The actual capital expenditure as a percentage of operational costs in relation to the basket commodity price index is shown in Figure 5.8.

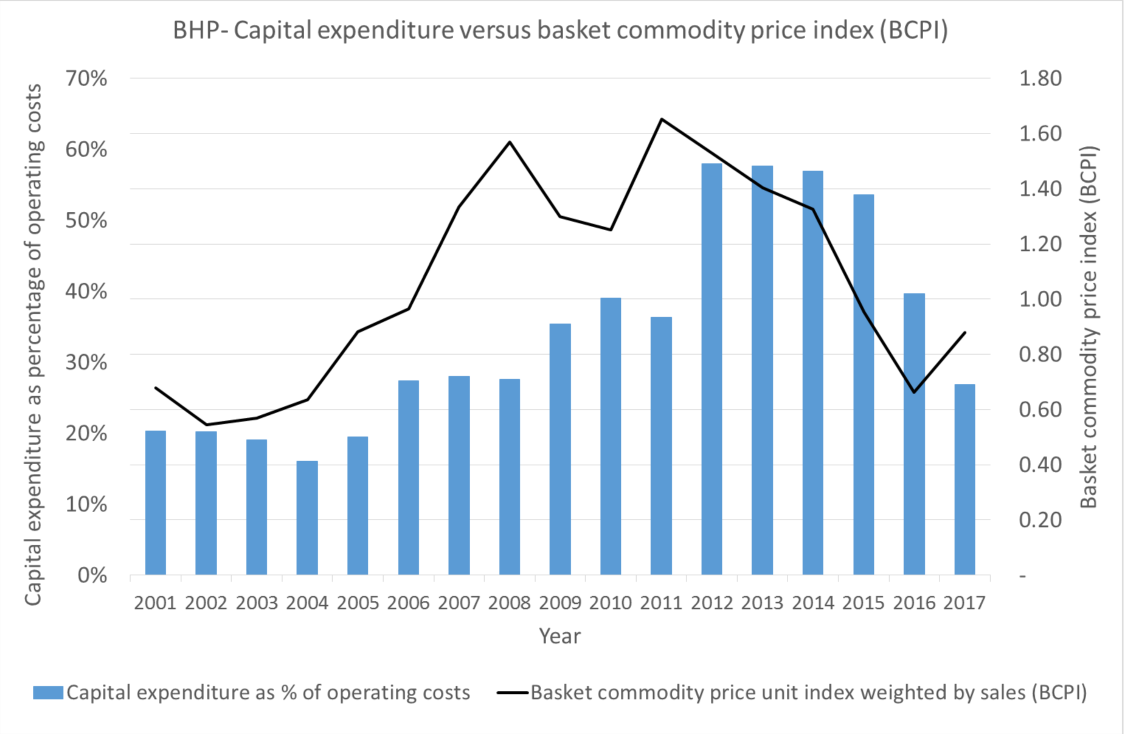

Figure 5.8: BHP capital expenditure as percentage of operational costs for the period 2001 to 2017

Figure 5.8 indicates a cyclical time lag between actual capital expenditure and the basket commodity price index. This is expected as there is typically a couple of years delay between the time of when a capital commitment is made and when actual capital expenditure is incurred. Figure 5.8 indicates that from 2006 there was a progressive year-on-year increase in the actual capital expenditure as a percentage of operational costs from 19% in 2005 to 58% in 2013. This corresponds with the increase in production volumes over this period as shown in Figure 5.5. Since 2015 there was a progressive decline in the actual capital expenditure to a low of 27% in 2017, which compares to BHP's average capital expenditure as a percentage of operational costs over the analysis period of 34%. Similar to capital commitments shown in Figure 5.6, the increase and decrease in actual capital expenditure was primarily in response to the respective increase and decrease in commodity prices.

5.6 Distributions to shareholders

Figure 5.9 indicates the total distribution of capital to shareholders, which includes both dividends and share buy-backs as a percentage of total revenue, in relation to the basket commodity price index.

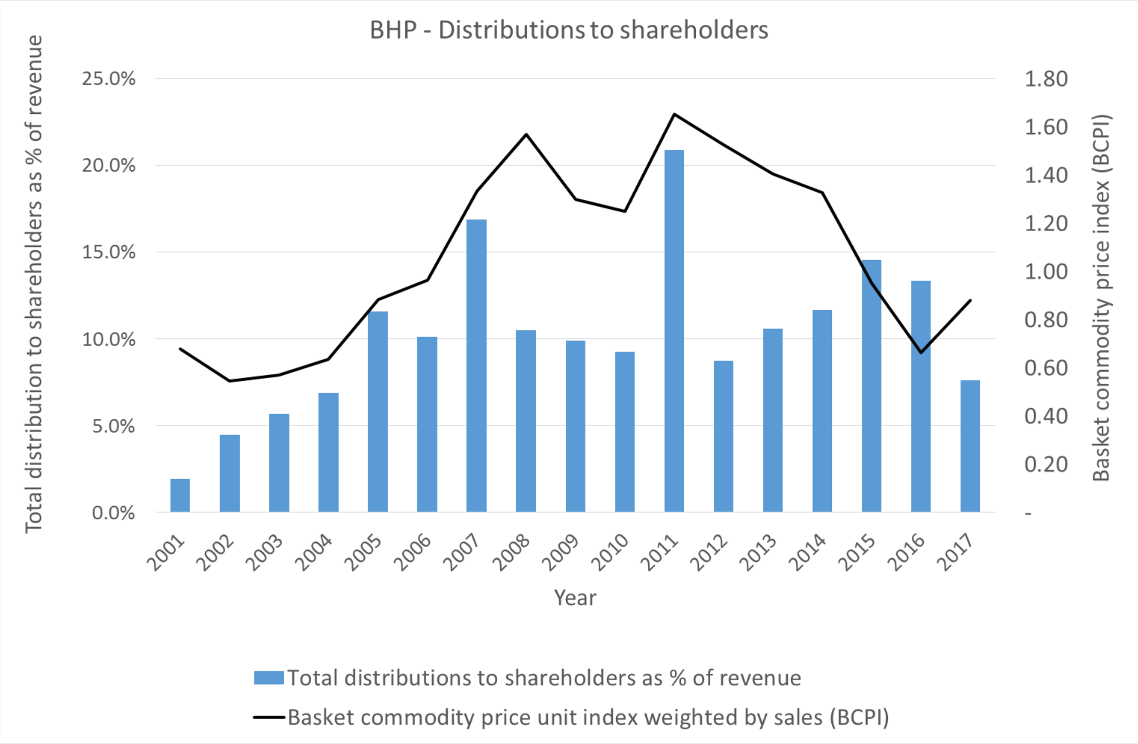

Figure 5.9: BHP distributions to shareholders for the period 2001 to 2017

Figure 5.9 indicates that BHP managed to increase distributions to shareholders over the analysis period. From 2002 to 2007 there was a progressive increase in the percentage returns to shareholders, primarily due to increasing commodity prices. The impact of the global financial crisis is evident in 2008 to 2010 with lower returns to shareholders. A change in capital allocation strategy in 2013, which placed a priority on returns to shareholders, resulted in a progressive increase in return to shareholders from 2012 to 2015, notwithstanding declining commodity prices (BHP, 2013). Figure 5.9 indicates significant increases in returns to shareholders in the years 2007 and 2011. This was due to large share buy-back programmes announced in both years. Notably, both years were close to or coincided with peaks of the basket commodity price index.

5.7 Balance sheet strength

BHP indicated that their strong balance sheet with low net debt gearing ratio and high cash flow to net debt coverage ratio, enabled it to isolate its operations from commodity price volatility and provide it with optionality to capitalise on opportunities (BHP, 2013). This is indicated in Figure 5.10 where it can be seen that BHP was well positioned for most of analysis period, to cover its debt obligations with average cash flow to net debt coverage ratios in excess of one.

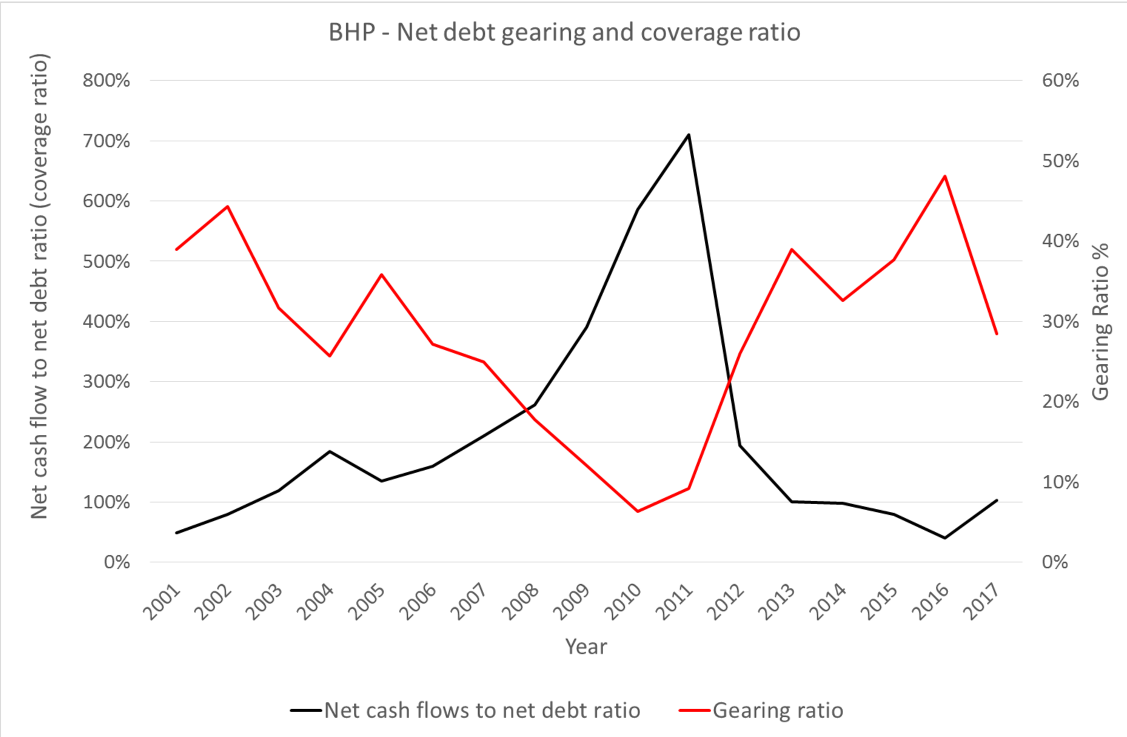

Figure 5.10: BHP net cash flows to net debt ratios for the period 2001 to 2017

The significant increase in the net cash flows to net debt ratio from 2008 to 2011 was due to a combination of strong operational performances and a higher allocation of capital towards repayment of debt during the global financial crisis. The increase in gearing ratio from the year 2011 to 2013 was due to higher allocation of capital towards growth projects as indicated in Figure 5.2. In the year

2013 BHP announced a strategic objective of preserving their strong balance sheet through adopting the following capital allocation framework (BHP, 2013):

- Allocate sufficient stay-in-business capital to enable sustainable operations;
- Maintain balance sheet strength through minimising debt gearing ratio and maximise debt coverage ratio;
- Distribute a minimum of 50% of the underlying profit to shareholders as dividends; and
- Remaining cash is allocated to where the highest return on capital can be obtained, which can be a combination of growth, reduction of debt, share buy-backs or dividend distribution.

5.8 Use of debt to finance capital commitments

The split between investments and repayment of debt is provided in Figure 5.11 which indicates a positive correlation between investment values and debt levels. The decision to either allocate capital to investments or repayment of debt is one of the key considerations in the capital allocation decision-making process. An important factor to consider in this decision is the company's balance sheet strength indicated by the gearing ratio. BHP's gearing ratio, net debt levels and net cash used in investment activities are shown in Figure 5.11.

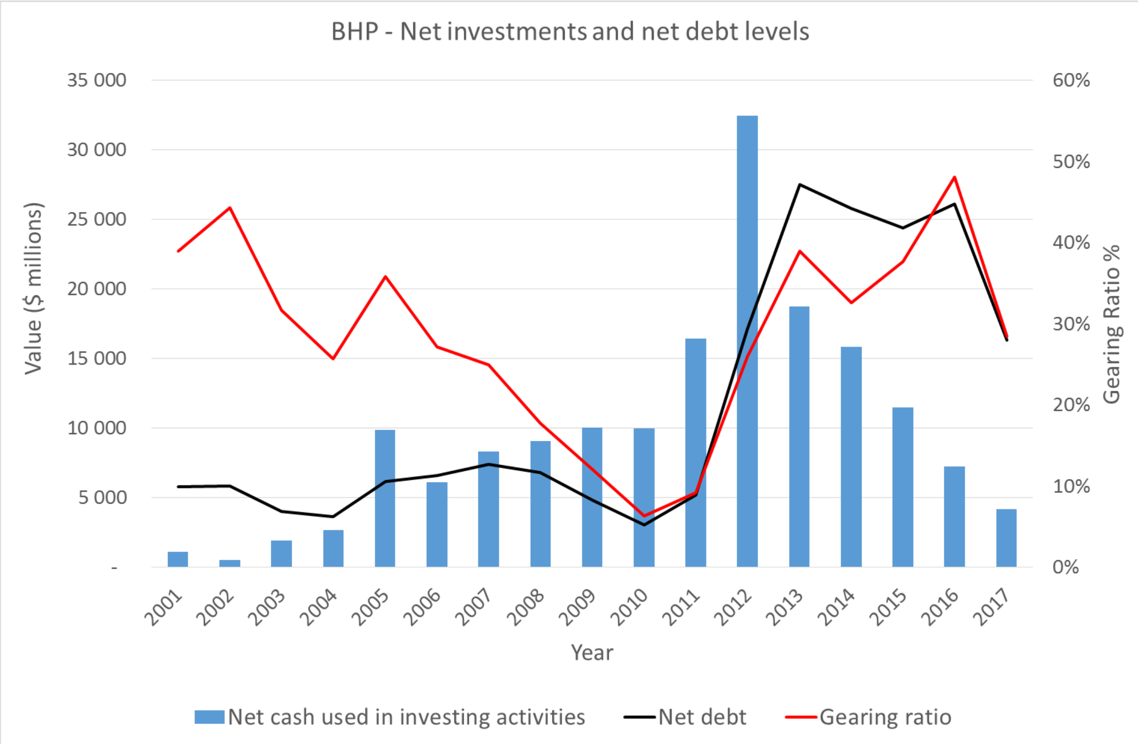

Figure 5.11: BHP split between net debt and net investments for the period 2001 to 2017

During 2001 to 2010 the total net debt value remained relatively constant, whilst the gearing ratio decreased from 39% to 6%. The decrease in gearing ratio whilst net debt remained relatively constant is primarily attributable to an increase in shareholders' equity from US$14.9 billion in 2001 to US$48.5 billion 2010. High capital investments during 2011 to 2015 increased the debt gearing ratio to a high of 48% in 2016. Substantial amount of capital was allocated to growth initiatives in 2012, with US$7.2 billion invested in the petroleum division and US$5.9 billion invested in the iron ore division.

5.9 Impairments

Figure 5.12 shows BHP's historical capital allocation and impairments relative to the basket commodity price unit index.

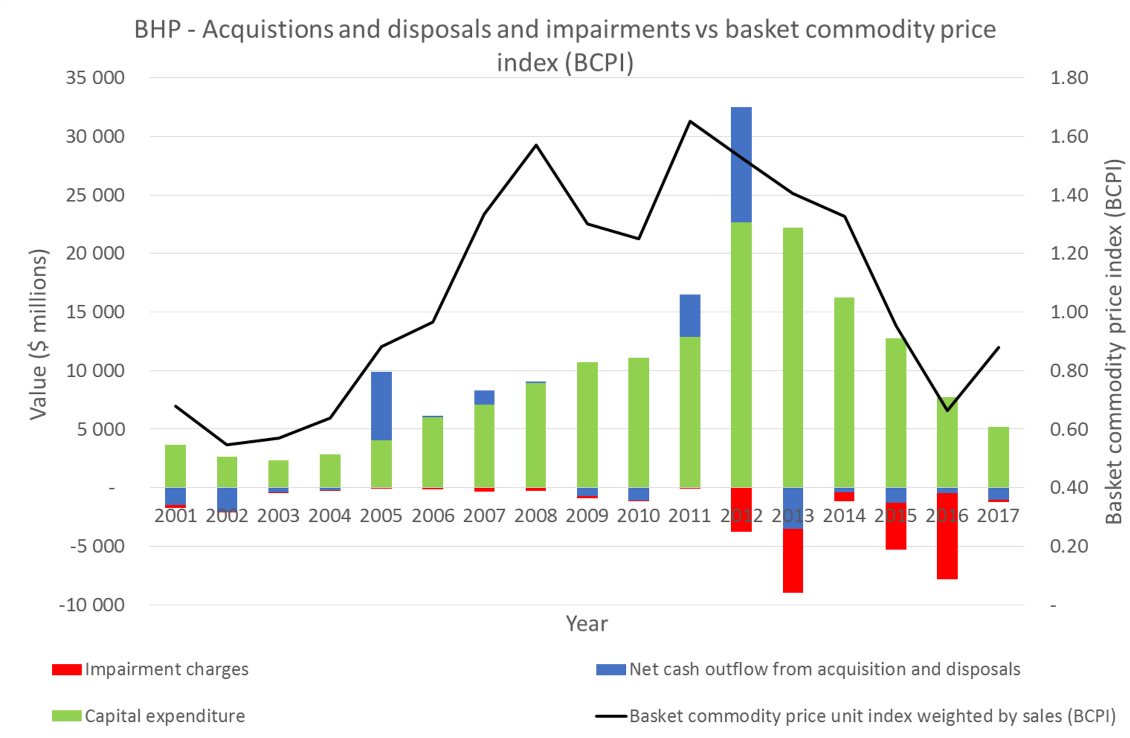

Figure 5.12: BHP historical capital allocation and impairments for the period 2001 to 2017

Notably, significant capital was allocated to expansionary capital expenditure from 2012 and 2015. There were many new major capital projects approved in 2012 and 2013. Included in this list are the US$1.2 billion development of the Olympic dam project, US$2.1 billion development of the Caval Ridge coal project, and a US$1.2 billion SIB project at Escondida copper mine. In 2013 a US$2.6 billion investment in the development of the Jansen potash project was announced. During the same period from 2012 to 2015 impairments of a total value of US$21.5 billion was announced. Table 5.2 provides a breakdown of the total capital allocated and total impairments from 2001 to 2017.

Table 5.2: Total net investments by BHP during 2001 to 2017

Description	Unit	Value	% of total net investment
Total net investment from 2001 to 2017	**$ millions**	**167 149**	**100%**
Total expansionary capital expenditure from 2001 to 2017	$ millions	121 157	72%
Total stay-in-business capital expenditure from 2001 to 2017	$ millions	37 810	23%
Total net acquisitions and disposals from 2001 to 2017	$ millions	8 182	5%
Total impairments from 2001 to 2017	$ millions	-23 144	-14%

Total impairments of US$23.1 billion was made from 2001 to 2017 which represents 14% of the invested capital during this period. This is substantially better than Anglo American's impairments equal to 32% of the invested capital during this period.

5.10 Return on capital employed

ROCE relative to net capital allocated to investment activities and the basket commodity price index are shown in Figure 5.13. The data points contained in Figure 5.13 are provided in Appendix 11.11.

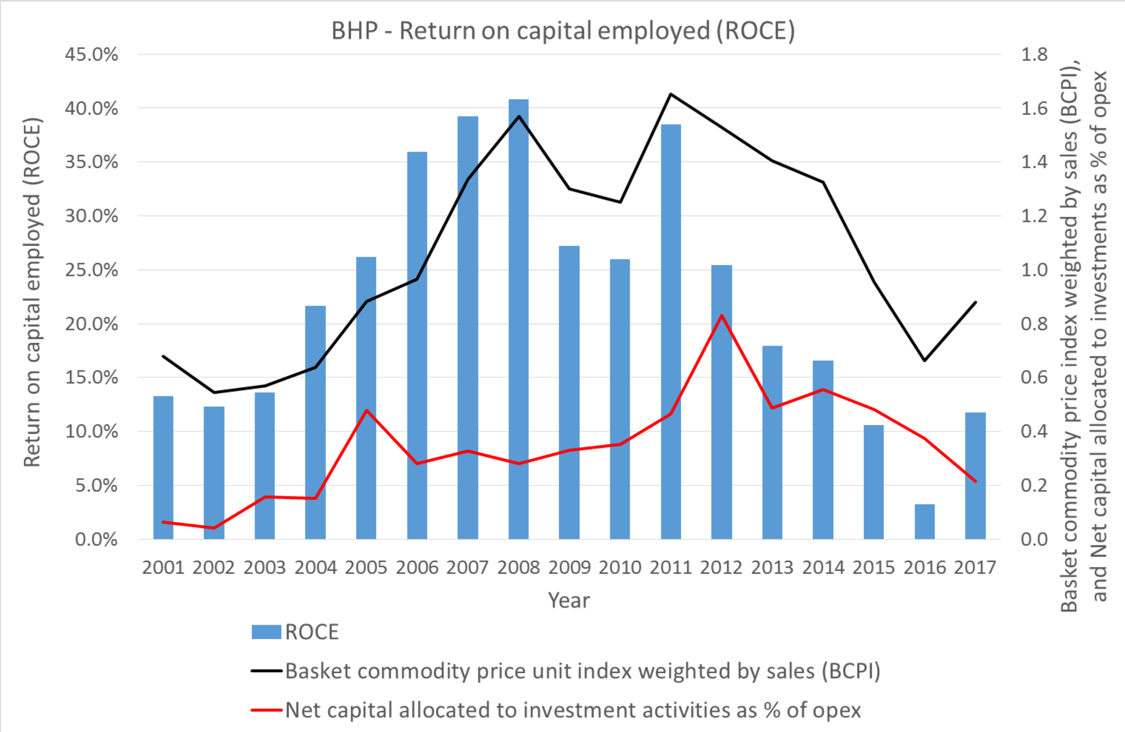

Figure 5.13: BHP ROCE for the period 2001 to 2017

Figure 5.13 indicates a strong positive linear relationship between ROCE and the basket commodity price index with a Pearson correlation coefficient of 0.67. This positive correlation is expected as commodity prices have a strong direct influence on revenue and earnings. Figure 5.13 indicates no meaningful correlation between the net capital allocated to investments as a percentage of annual operational costs and the ROCE. This is confirmed by the low Pearson correlation coefficient of 0.175, which indicates that the amount of capital allocated to investments are not influencing the investment returns. Figure 5.14 shows ROIC relative to net capital investments and the prevailing commodity prices.

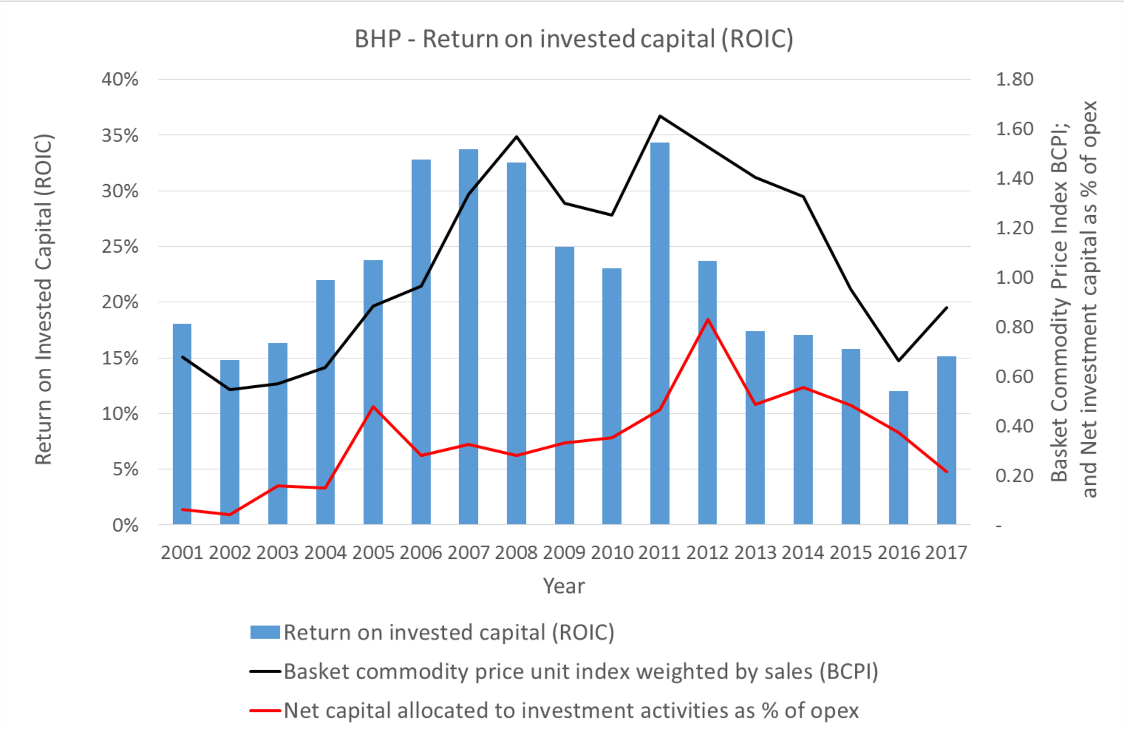

Figure 5.14: BHP ROIC for the period 2001 to 2017

The Pearson correlation coefficient between ROIC and the basket commodity price index over the 17 year analysis period is 0.61. This strong positive linear relationship is expected as commodity prices have a direct influence on the return on invested capital. Similar to ROCE, Figure 5.14 indicates a weak positive linear relationship between ROIC and net capital allocated to investments as a percentage of operational costs, with a Pearson correlation coefficient of 0.15. This indicates that amount of capital invested by BHP had little influence on the return on capital achieved.

5.11 Hypothesis test

Figure 5.15 indicates ROIC relative to CIPCI. Figure 5.15 shows the results from the test of the hypothesis that timing of capital allocation decisions in relation to the prevailing commodity prices has an influence on the returns realised on the capital expenditure.

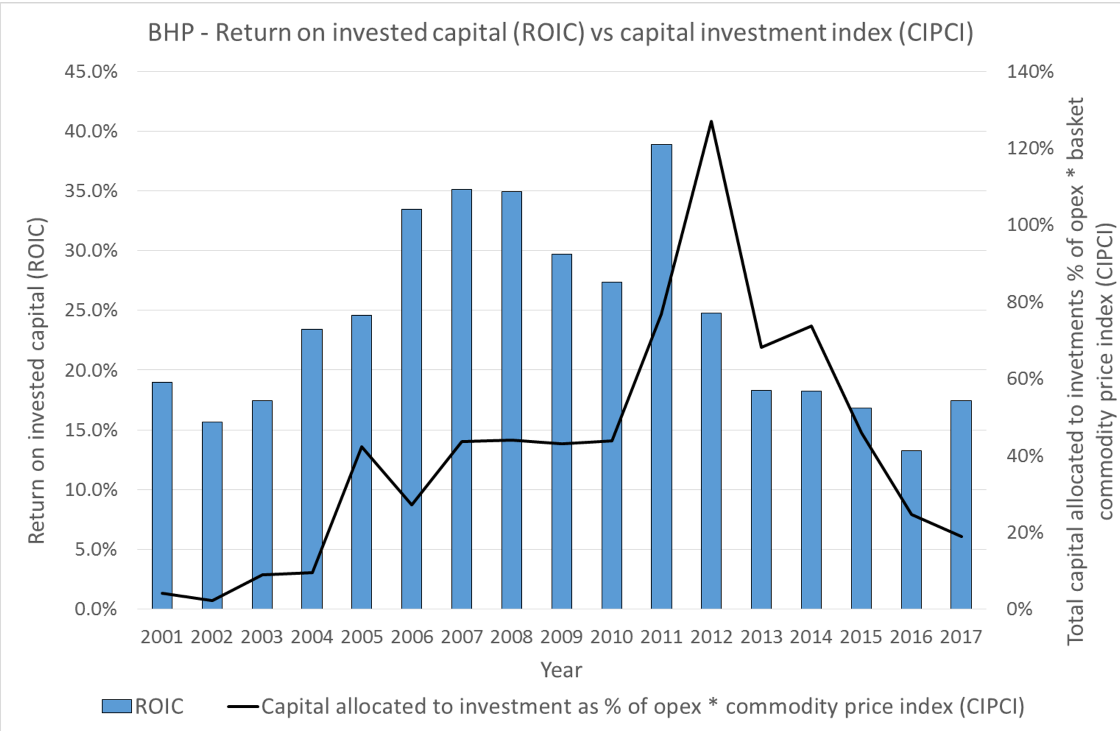

Figure 5.15: BHP ROIC as a function CIPCI for the period 2001 to 2017

Similar to the results obtained for Anglo American, Figure 5.15 indicates a weak positive linear relationship between ROIC and CIPCI. Figure 5.15 also indicates a time lag between ROIC and CIPCI, where similar to the results obtained for Anglo American, the ROIC cycle seems to lead the CIPIC index by a couple of years. The time lag between the two cycles could be due to the time duration between when mining capital investments were made and when return on investments were realised. Figure 5.15 also indicates high variability in CIPCI index which indicates that typically BHP did not follow a contrarian investment approach where capital expenditure is increased during periods of lower commodity prices. In order to test the linear relationship between ROIC and CIPCI a scatter diagram was developed for ROIC and CIPIC as shown in Figure 5.16.

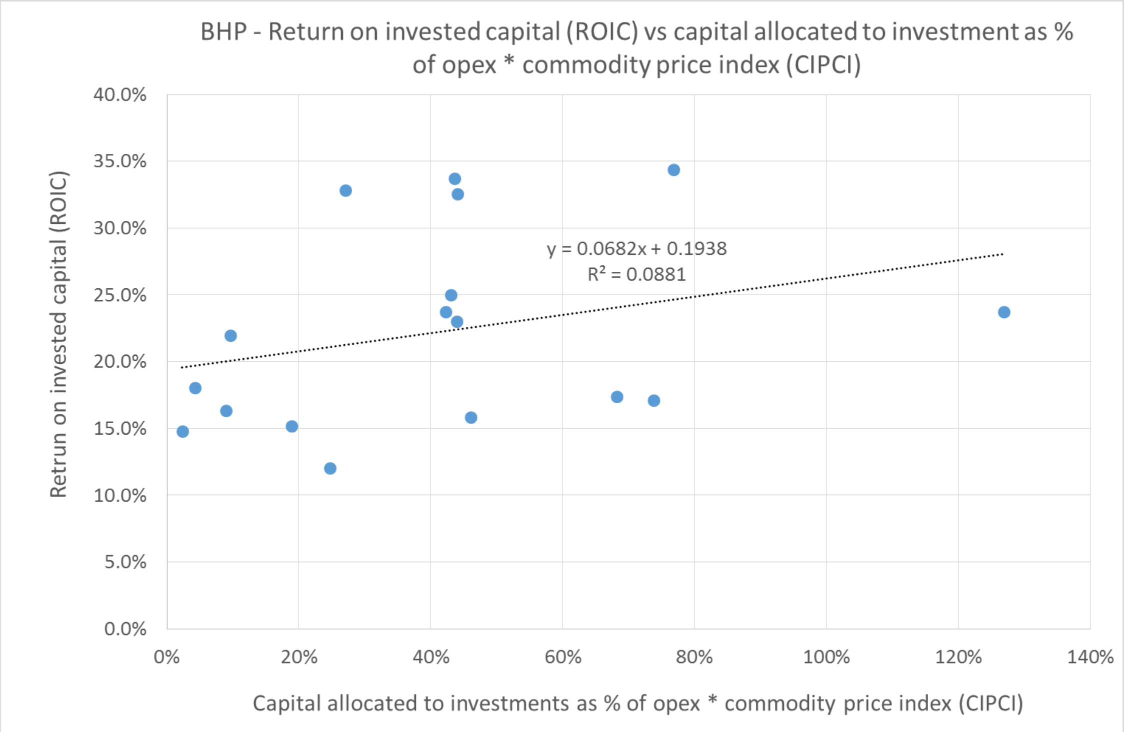

Figure 5.16: BHP - scatter diagram of ROIC and CIPCI for the period 2001 to 2017

Figure 5.16 indicates a weak positive linear relationship between ROIC and CIPCI. The coefficient of determination (R^2) is 0.09 which means that only 9% of the variations in ROIC can be explained by variations in CIPCI. The Pearson correlation coefficient is 0.15 indicating a weak positive linear relationship. Figure 5.17 shows ROCE relative to CIPCI.

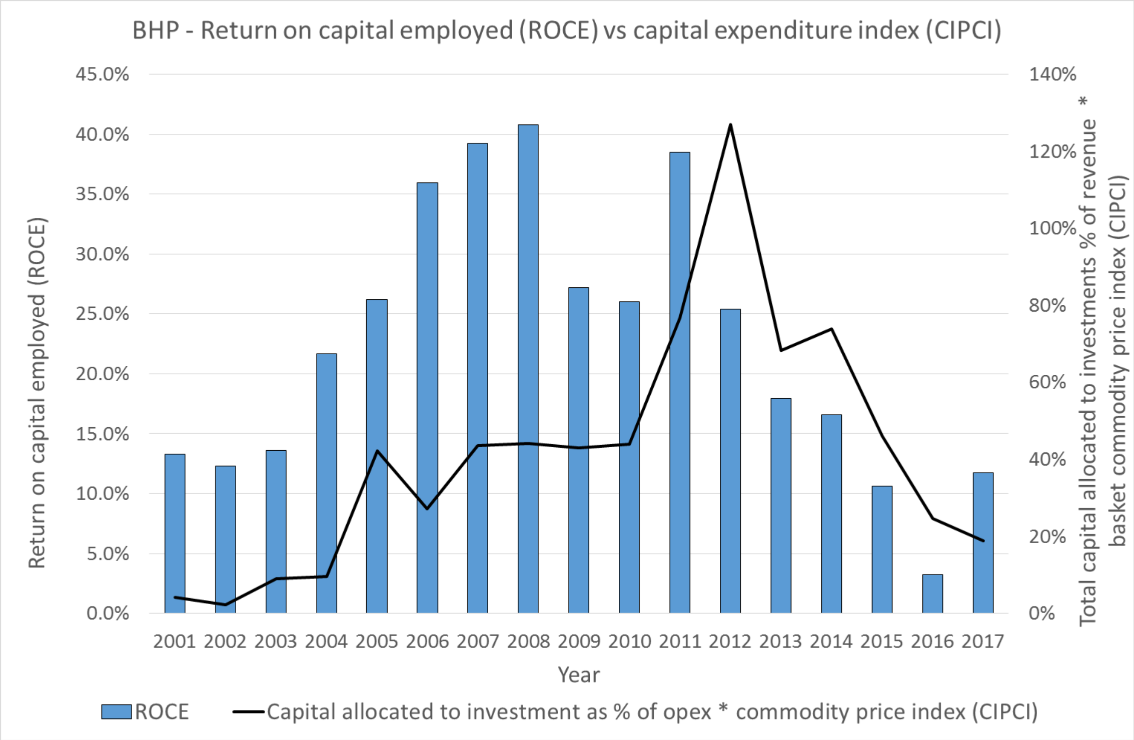

Figure 5.17: BHP ROCE as a function of CIPCI for the period 2001 to 2017

Figure 5.17 illustrates a similar relationship between ROCE and CIPCI as obtained between ROIC and CIPCI. A scatter diagram was used to test the linear relationship between ROCE and CIPCI as shown in Figure 5.18.

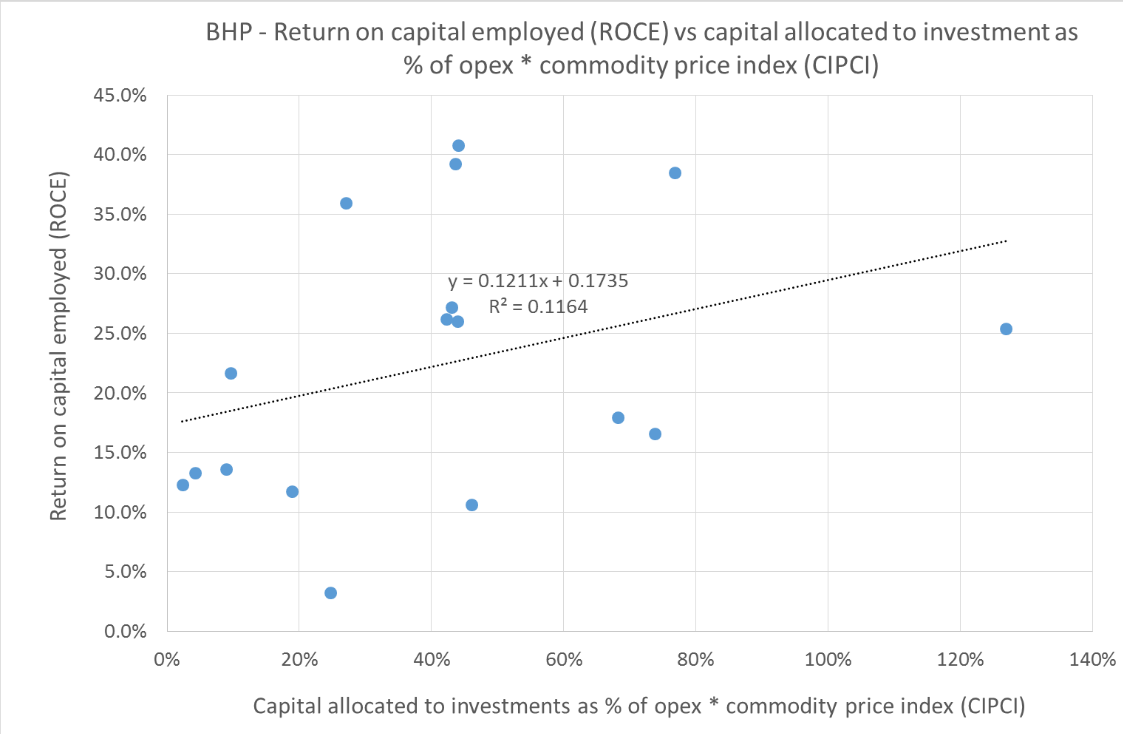

Figure 5.18: BHP - scatter diagram of ROCE and CIPCI for the period 2001 to 2017

Figure 5.18 indicates a moderate positive linear relationship between ROCE and CIPCI. The coefficient of determination (R^2) is 0.12, which means that only 12% of the variations in ROCE can be explained by variations in CIPCI. The Pearson correlation coefficient between the basket commodity price index and the value of capital commitments is 0.34, indicating a moderate positive linear relationship.

In order to test the impact of the time lag between ROCE and CIPCI, in Figure 5.19 the relationship is shown between CIPCI and ROCE achieved four years after the capital investment was completed. In contrast to the results obtained for Anglo American, a higher negative correlation was obtained for BHP if the time lag between CIPCI and ROCE was increased from three years to four years.

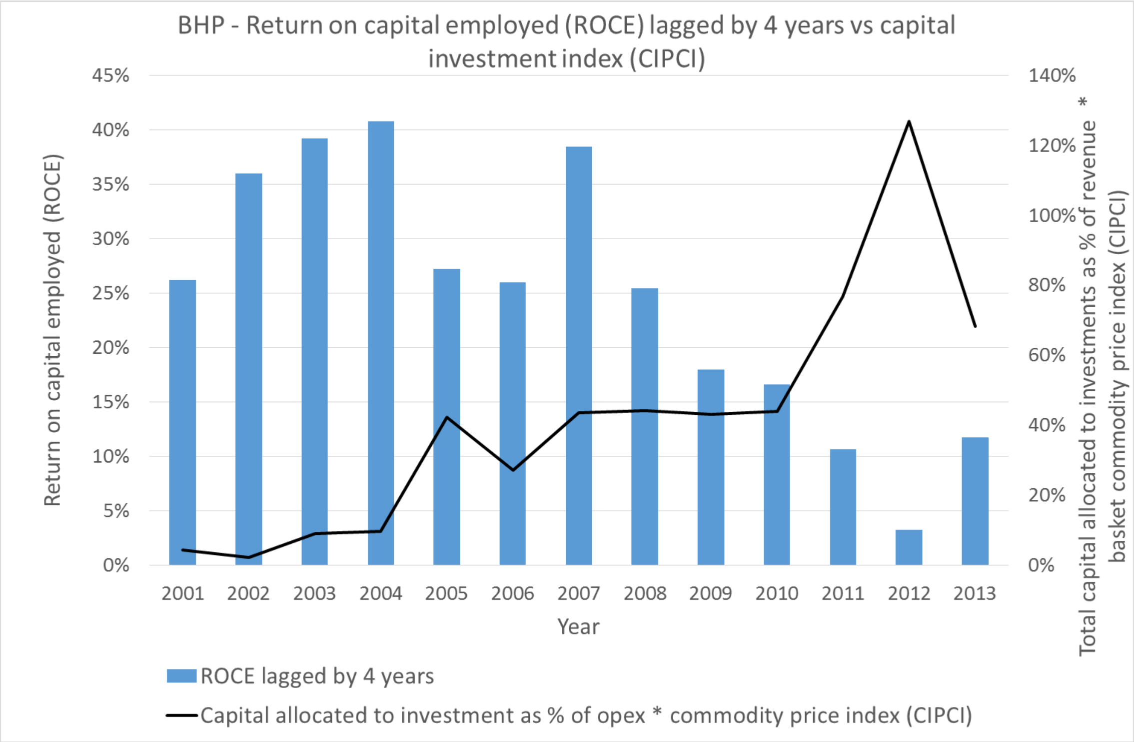

Figure 5.19: BHP ROCE lagged by 4 years as a function of CIPCI for the period from 2001 to 2013

Similar to the results obtained with Anglo American, if the ROCE four years after the capital investment was made is compared to the capital investment index, then a stronger negative linear relationship was obtained. In Figure 5.20 a scatter diagram indicates the linear relationship between CIPCI and ROCE four years after the investment was made.

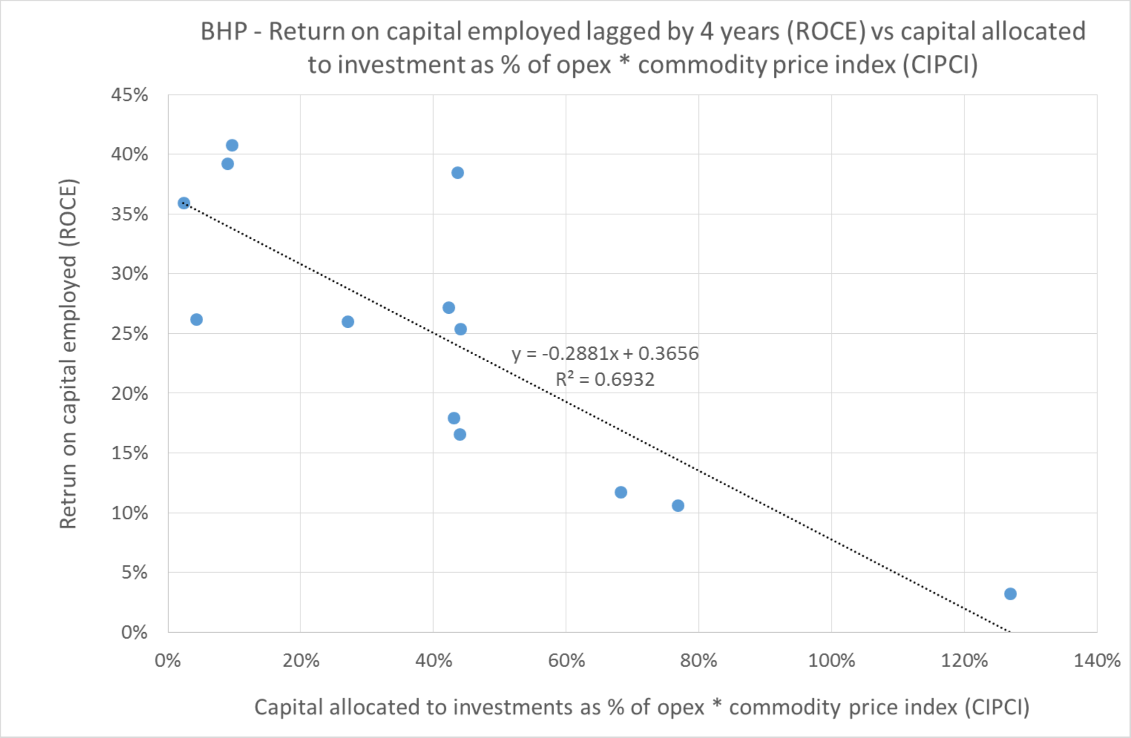

Figure 5.20: BHP – scatter diagram of ROCE lagged by 4 years and CIPCI for the period from 2001 to 2013

Figure 5.20 indicates a coefficient of determination (R^2) of 0.69, which indicates that 69% of the variations in ROCE obtained four years after the investment was made can be explained by variations in CIPCI at the time of the investment. The Pearson correlation coefficient is -0.83, which indicates a strong negative linear relationship. Based on this result it can be reasoned that capital investments during periods of relatively high commodity prices typically had lower ROCE's four years after the investment was made, and vice versa.

5.12 Chapter summary

BHP over the analysis period produced a well-diversified mix of commodities with a relative even distribution of revenue split between the commodities. BHP increased real terms EBITDA by 724% between 2001 and 2017. This was achieved through a combination of production volume growth and increase in net operating margin.

During periods of high commodity prices relative to historical prices, from 2005 to 2008, and 2009 to 2012, BHP's strategic focus was on production volume growth. The emphasis on growth contributed to more capital allocated to expansion capital expenditures during these periods. BHP's growth strategy typically focused more on brownfields and greenfields project capital expenditure and less on acquisitions.

There is a strong positive linear relationship between the relative strength of the prevailing commodity prices and value of capital commitments, with a Pearson correlation coefficient of 0.82. In a declining commodity price environment, from the year 2013 to 2017, BHP's capital allocation strategy changed from prioritising growth to maximising returns on capital employed and returning capital to shareholders. The change in capital allocation strategy contributed to a reduction in capital allocated to expansionary capital expenditure and acquisitions.

In the hypothesis test a high negative correlation was found between CIPCI and ROCE four years after the investment was made. This indicates that capital allocated during periods of relative high commodity prices had below average investment returns four years after the investment was made, and vice versa. The results from the historical capital allocation analysis for Rio Tinto are provided and discussed in the next chapter.

6 ANALYSIS OF CAPITAL ALLOCATION BY RIO TINTO

6.1 Chapter overview

In this chapter the results from the research study on Rio Tinto are presented and analysed. The analysis of Rio Tinto followed the same process as the analysis conducted on Anglo American and BHP provided in Chapter 4 and 5 respectively.

6.2 Historical capital allocation

Rio Tinto's historical allocation of capital to either building of new assets, purchase of new assets or returning capital to shareholders are provided in Figure 6.1. The terms build, buy and return are as defined in sub-section 3.2.1. The data points contained in Figure 6.1 are provided in Appendix 11.17 and Appendix 11.18.

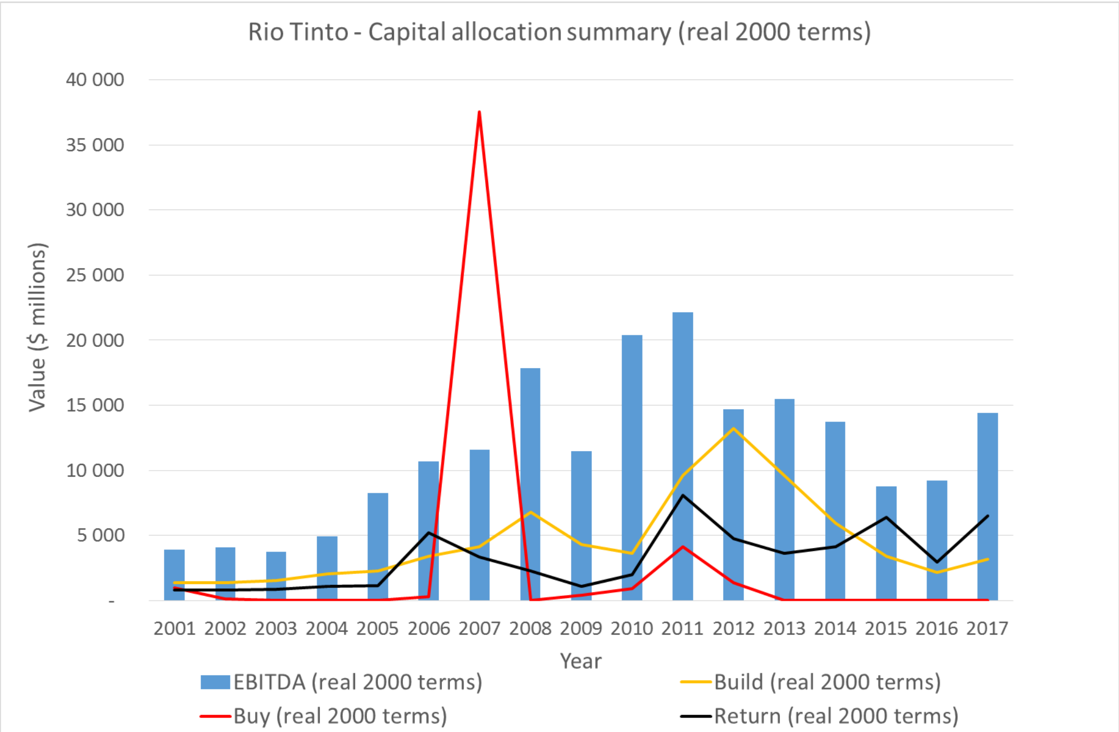

Figure 6.1: Rio Tinto summary of historical capital allocation for the period 2001 to 2017

Similar to Anglo American and BHP, Figure 6.1 indicates that Rio Tinto allocated significantly more capital to building new assets and stay-in business capital compared to buying new assets. The significant increase in the buy graph in the year 2007 is due to the US$38.7 billion acquisition of Alcan Inc. Similar to BHP, Rio Tinto was successful in progressively increasing the amount of capital returned to shareholders between 2001 and 2017. Similarly, as indicated in the build graph, capital allocated to expansion projects and stay-in-business projects increased progressively from 2001 to 2012, after which it also reduced in-line with the reduction in commodity prices. The major capital allocation decisions made by Rio Tinto over the analysis period are summarised below (Rio Tinto, 2001 – 2017):

- From the years 2001 to 2008 Rio Tinto allocated progressively higher amounts of capital to build projects. A list of major capital projects approved by Rio Tinto during this period are provided below:
    - In September 2004 a US$2.3 billion expansion of the Gove Alumina Refinery was approved. This capital investment increased production capacity from 2.0 to 3.8 million tonnes per annum; and
    - In 2007 a number of capital projects were approved namely; construction of an underground diamond mine at Diavik for US$787 million; development of the Mesa A iron ore project for US$901 million; development of the Block 4 development project with a capital cost of US$1 521 million; and expansion and extension of the Kestrel coal mine for US$991 million.
- The significant increase in the buy graph in 2007 is due to the acquisition of Alcan Inc. for US$38.7 billion. The size of the Alcan acquisition was more than twice the value of Rio Tinto's shareholders' equity of US$18.2 billion at end 2006. Alcan Inc. was the parent company of a group of vertical integrated aluminium production companies involving bauxite mining, alumina refining and aluminium smelting and refining;
- During 2009 Rio Tinto acquired a 9.8% interest in Ivanhoe Mines for a total amount of US$388 million, which increased Rio Tinto's interest in

Ivanhoe Mines to 19.7%. The primary interest for Rio Tinto was the development of the Oyu Tolgoi copper project in Mongolia;

- During 2010 Rio Tinto acquired an additional 20.6% interest in Ivanhoe Mines for a total amount of US$1,588 million, which increased Rio Tinto's interest in Ivanhoe Mines to 40.3%;
- The increase in the buy graph in 2011 is primarily due to two major acquisitions completed in 2011 namely; an increase in Rio Tinto's interest in Ivanhoe Mines to 49% for a total amount of US$1,860 million; and the acquisition of Riversdale Mining Limited for a total cost of US$4.2 billion. After completion of the acquisition the name of the operation in Mozambique was changed to Rio Tinto Coal Mozambique;
- The increase in the build graph in 2012 is due to a number of development projects approved in 2012 with a total value US$14.8 billion. This included phase one of the Oyu Tolgoi copper and gold mine project with a total capital cost of US$6.2 billion;
- In January 2013 Rio Tinto announced a significant US$14 billion impairment charge on its 2012 full year results. The impairment charge was spilt as US$3 billion against the Rio Tinto Coal Mozambique operations and US$11 billion against Rio Tinto's aluminium assets. The significant impairment charge directly led to the resignation of Tom Albanese, Rio Tinto's CEO. The US$14 billion impairment charge was equal to 30% of Rio Tinto's shareholder capital at the end of 2012;
- No new major capital projects with a capital cost greater than US$1 billion were approved in 2013, 2014, or 2016, which is reflected in the decrease in the build graph from 2012 to 2016;
- In response to the lower commodity prices a number of disposals were completed in 2013:
  - ➢ Northparkes mine was sold to China Molybdenum Co. Ltd. for a total amount of US$820 million;

  - Palaborwa Mining Company Limited was sold for US$373 million to a consortium led by Industrial Development Corporation of South Africa and Hebei Iron & Steel Group;
  - Eagle copper and nickel project was sold for US$315 million to Lundin Mining Corporation; and
  - Altynalmas Gold was sold for US$235 million to Sumeru Gold B.V.
- During 2014 the following disposals were concluded by Rio Tinto:
  - Clermont Joint Venture was sold to GS Coal for a total amount of US$1.0 billion; and
  - Rio Tinto Coal Mozambique was sold to International Coal Ventures Private Limited for a total amount of US$50 million.
- In January 2017 Rio Tinto announced the disposal of its thermal coal operations in Australia for a total amount of US$2.69 billion.

Analysis of the major capital allocation decisions by Rio Tinto over the analysis period reveals similar results to Anglo American and BHP, with significant amounts of capital allocated to growth projects and acquisitions during periods of high commodity prices, and disposals of assets and impairments announced during period of low commodity prices. A more detailed split of the historical capital allocation between stay-in-business capital expenditure, expansion capital expenditure, acquisitions and disposals and total capital returns to shareholders over the analysis period is provided in Figure 6.2. Figure 6.2 also shows the net cash flows from operating activities and the basket commodity price index. The data points contained in Figure 6.2 are provided in Appendix 11.17 and Appendix 11.18.

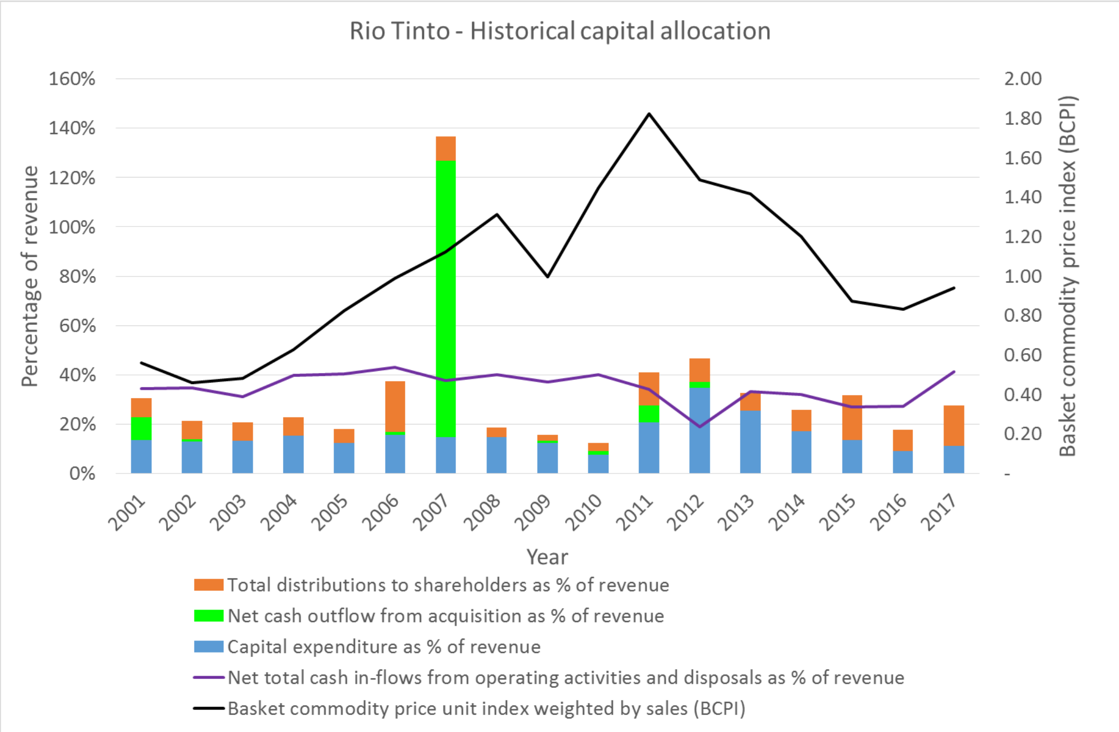

Figure 6.2: Rio Tinto summary of historical capital allocation

The US$38.7 billion acquisition of Alcan Inc. in 2007 is the most significant capital allocation decision made by Rio Tinto during the analysis period. The acquisition was made when commodity prices were relatively high, and proved to be a poor investment decision as confirmed with the US$11 billion impairment announced in 2013 against Rio Tinto's aluminium assets. Figure 6.2 indicates that in the years following the major acquisition in 2007, total capital allocations were significantly less than capital inflows from operating activities as Rio Tinto focussed on repayment of debt incurred in financing the Alcan Inc. acquisition. During periods of higher commodity prices in 2011 and 2012, total capital allocations exceeded net cash in-flows from operating activities. This was due to a number of development projects approved in 2011 and 2012 of which the largest was the US$6.2 billion Oyu Tolgoi copper and gold project. Notably, following the change in executive management in 2013 there was a higher allocation of capital to distributions to shareholders in the form of dividends and share buy-backs.

6.3 Overview of historical financial performance

An overview of the financial performance of Rio Tinto over the analysis period is provided in Figure 6.3 where total revenue, total capital expenditure, total operational costs and EBITDA are provided in real 2000 terms.

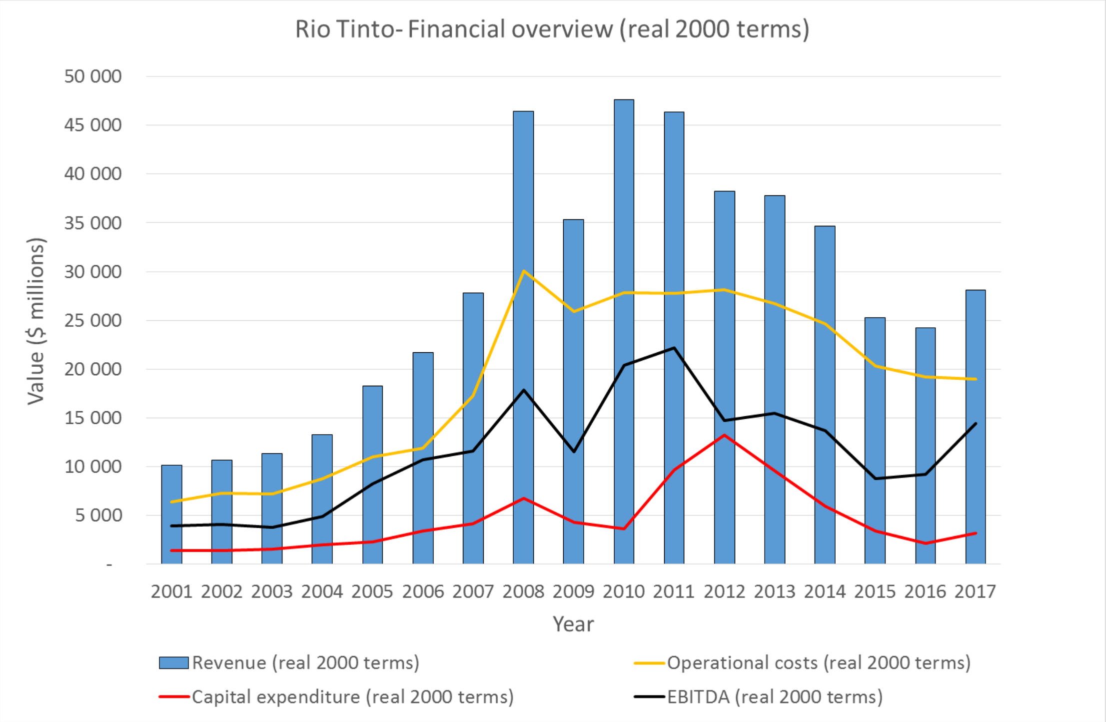

Figure 6.3: Financial overview of Rio Tinto for the period 2001 to 2017

Figure 6.3 indicates a positive year-on-year increase in real term revenue between 2001 and 2010 with a positive CAGR of 18.7%. This was primarily due to increases in commodity prices and the Alcan Inc. acquisition completed in 2007. From 2010 to 2016 revenue decreased by an average negative annual growth rate of -10.6% due to decreases in commodity prices. The significant increase in revenue in 2008 is due to the US$38.7 billion acquisition of Alcan Inc. Rio Tinto managed to increase EBITDA by 267% in real 2000 terms between 2001 and 2017, which is an average real term CAGR of 8.5%. Total capital expenditure progressively increased in line with year-on-year increases in revenue during 2001 to 2012, and subsequently decreased from 2012 to 2017.

Figure 6.3 also indicates a large increase in operational costs in 2008 which was due to the Alcan Inc.’s operational costs reflecting in Rio Tinto’s financial results.

6.4 Revenue and production volume growth

Figure 6.4 shows the basket commodity price index and Rio Tinto’s revenue in real 2000 terms split by commodity produced. A significant portion of Rio Tinto’s revenue was derived from iron ore sales, with approximately 49% of revenue derived from iron ore in 2017. The revenue contribution from iron ore increased over the analysis period as indicated in Figure 6.4. The data points contained in Figure 6.4 are contained in Appendix 11.20 to Appendix 11.24.

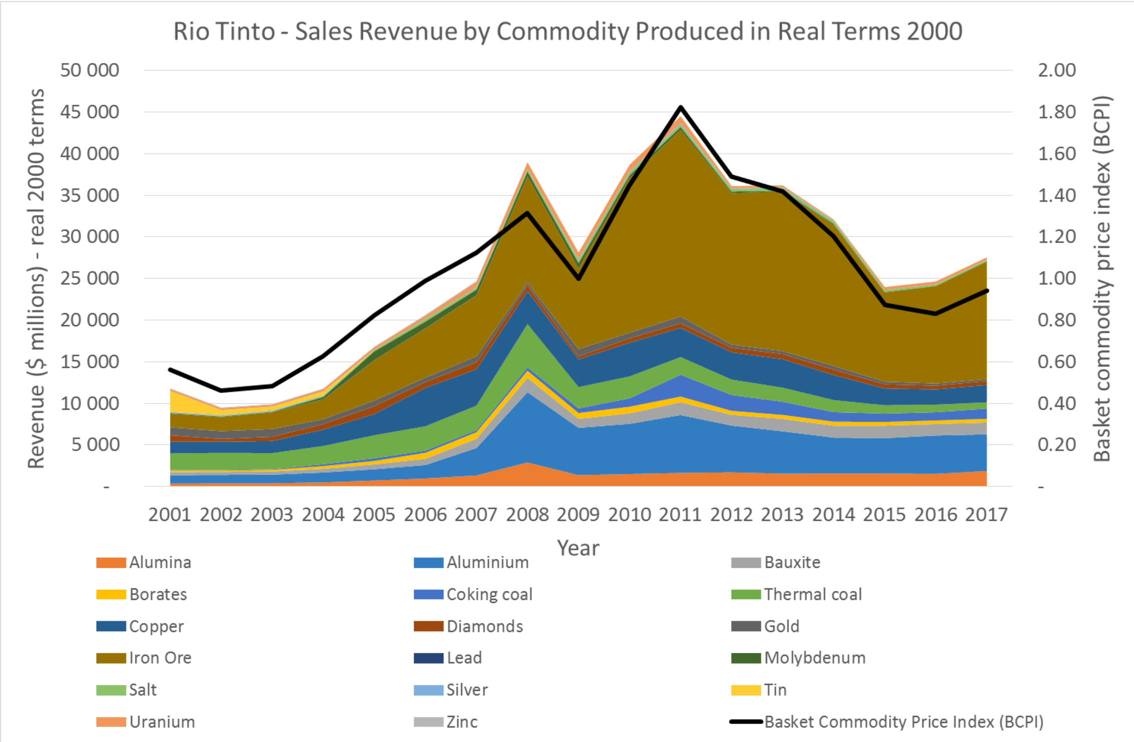

Figure 6.4: Rio Tinto revenue from commodities production in real 2000 money terms

Similar to the results obtained for Anglo American and BHP, Figure 6.4 indicates a perfect positive linear relationship between total revenue and weighted average basket price index with a Pearson correlation coefficient of 0.98. Table 6.1

provides the percentage revenue split between commodities produced by Rio Tinto in the periods 2002, 2008, 2011 and 2017.

Table 6.1: Rio Tinto revenue split by commodity produced

Revenue split by commodity produced	**Unit**	**2001**	**2008**	**2011**	**2017**
Alumina	%	2.9%	7.1%	3.6%	6.5%
Aluminium	%	8.2%	20.9%	15.2%	15.3%
Bauxite	%	3.0%	4.3%	3.3%	4.9%
Borates	%	1.6%	2.1%	1.5%	1.5%
Coking coal	%	0.5%	1.0%	5.7%	4.3%
Thermal coal	%	16.3%	12.9%	4.6%	2.6%
Copper	%	11.4%	9.7%	7.7%	7.2%
Diamonds	%	6.5%	1.7%	1.2%	1.7%
Gold	%	7.8%	0.9%	1.8%	0.8%
Iron Ore	%	13.5%	31.5%	49.1%	49.0%
Lead	%	0.2%	0.0%	0.0%	0.0%
Molybdenum	%	0.6%	1.4%	0.8%	0.2%
Nickel	%	0.5%	0.0%	0.0%	0.0%
Salt	%	0.5%	0.7%	0.7%	0.5%
Silver	%	0.6%	0.1%	0.2%	0.1%
Tin	%	20.7%	0.0%	0.0%	0.0%
Titanium dioxide slag	%	2.8%	3.8%	2.6%	4.3%
Uranium	%	1.6%	1.9%	1.9%	1.0%
Zinc	%	0.7%	0.0%	0.0%	0.0%
Total	**%**	**100%**	**100%**	**100%**	**100%**
Number of commodities produced		**19**	**17**	**15**	**15**

Due to a combination of disposals and production volume growth in certain commodities, Rio Tinto since 2009 became more reliant on a smaller pool of commodities namely, aluminium and associated minerals, coal, copper, and iron ore. In 2017 90% of total revenue was derived from these four commodities and their associated minerals. Notably, over the analysis period from 2001 to 2017 Rio Tinto reduced the number of commodities produced by 21% from 19 in 2001 to 15 products in 2017. This is a similar trend to Anglo American and BHP. Figure 6.5 shows the growth in production volumes relative to the production volumes achieved in the year 2001. Figure 6.5 also shows the net capital allocated to investment activities as a percentage of operational costs.

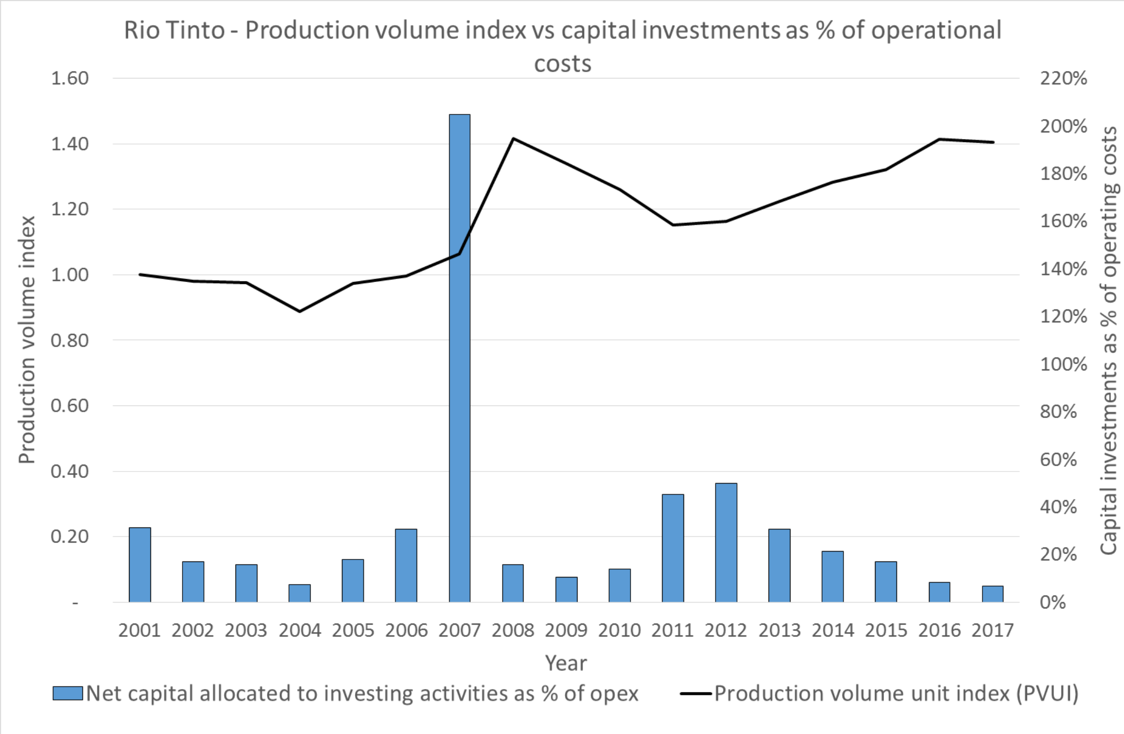

Figure 6.5: Rio Tinto production volume growth index

Over the analysis period the production volume index progressively increased by 40% which is a CAGR of 2.1%, which was primarily due to Rio Tinto's capital allocation towards growth activities equal to 32% of the annual operational costs expenditure. The stand-out investment is in 2007 when Rio Tinto committed US$38.1 billion for the acquisition of Alcan Inc. (Rio Tinto, 2007).

6.5 Capital commitments and actual capital expenditure

Capital commitments towards SIB capital and expansionary capital in real 2000 terms, are indicated in Figure 6.6 relative to the basket commodity price index.

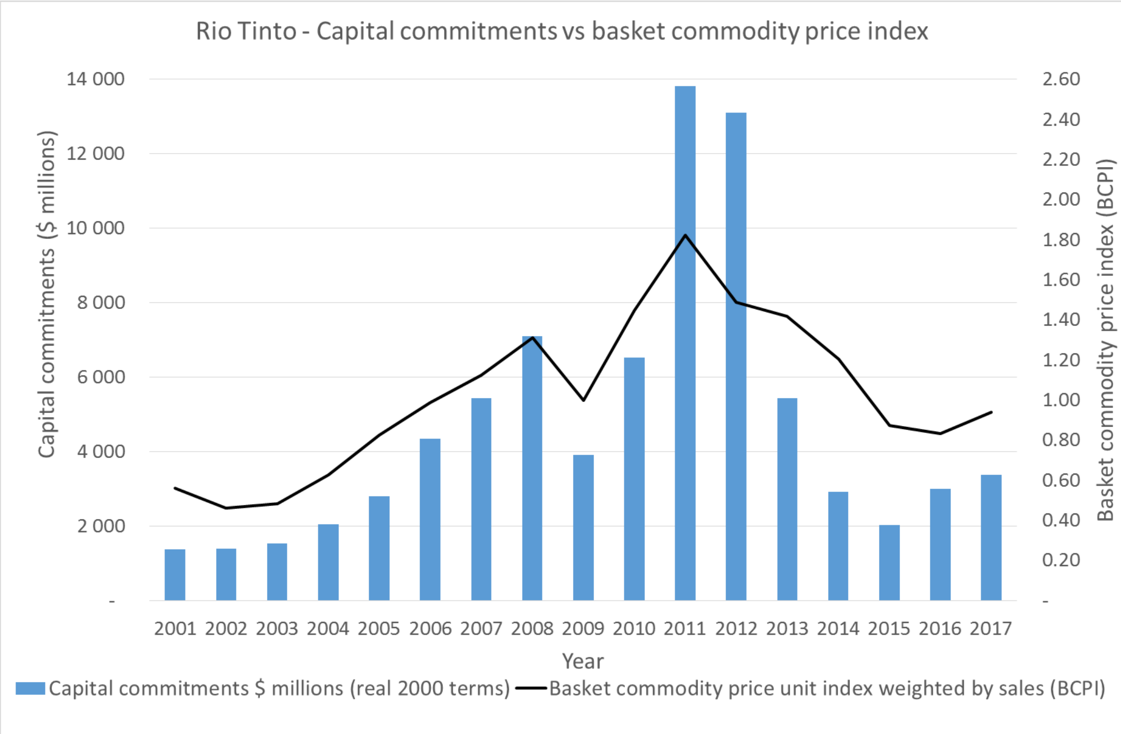

Figure 6.6: Rio Tinto capital commitments relative to prevailing commodity prices for the period 2001 to 2017

Similar to results for Anglo American and BHP, there is a strong positive correlation between the prevailing commodity price and value of capital commitments, with a typical lag of one year. This indicates that Rio Tinto historically committed more capital during times of relatively high commodity prices. In Figure 6.7 the linear relationship between the capital commitments and the prevailing commodity prices is represented in a scatter diagram.

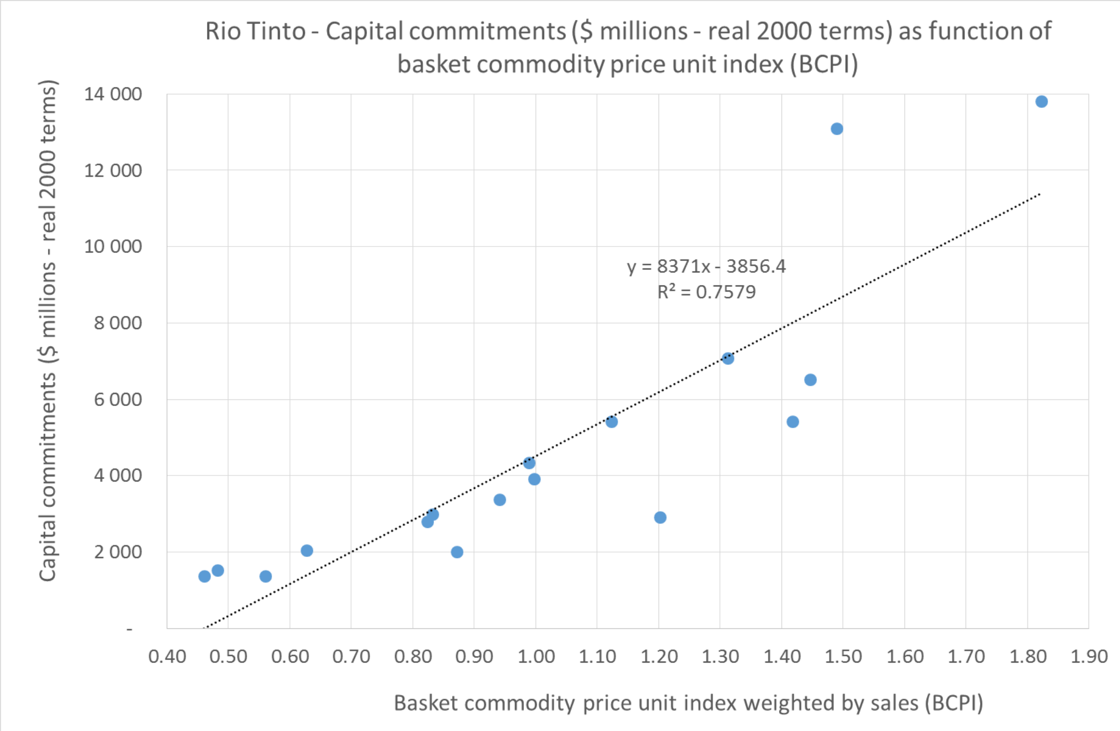

Figure 6.7: Rio Tinto - scatter diagram of capital commitments relative to prevailing commodity prices for the period 2001 to 2017

Figure 6.7 indicates a strong positive linear relationship between capital commitments and the prevailing basket commodity prices. The coefficient of determination (R^2) is 0.76, which means that 76% of the variations in the amount of capital allocated can be explained by variations in the prevailing basket commodity prices index. The Pearson correlation coefficient between the basket commodity price index and the value of capital commitments is 0.86, indicating a strong positive linear relationship. The actual capital expenditures as a percentage of operational costs relative to the basket commodity price index are indicated in Figure 6.8.

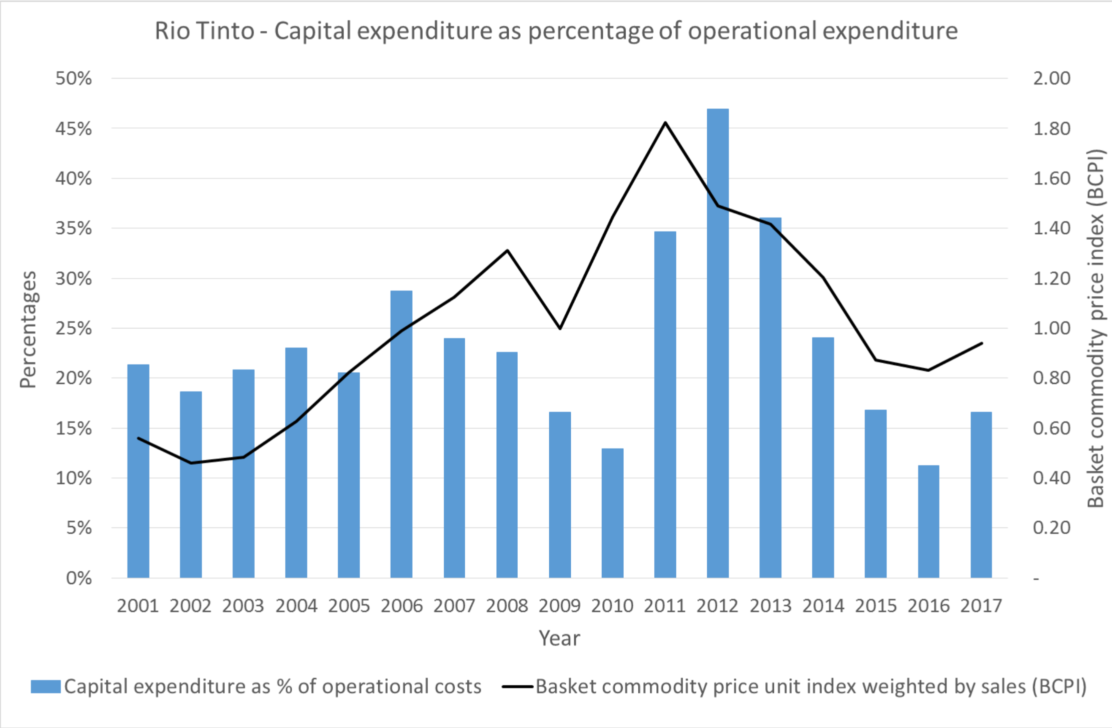

Figure 6.8: Rio Tinto capital expenditure as percentage of operational costs for the period 2001 to 2017

Figure 6.8 indicates a strong positive linear relationship between actual capital expenditure as percentage of operational costs and the basket commodity price index with a Pearson correlation coefficient of 0.54. This is a lower correlation compared to the results obtained for Anglo American and BHP, which could be due to the significant cost of the Alcan Inc. acquisition in 2007. Following the acquisition there was a progressive decrease in capital expenditure from 2007 to 2010 to allow for the repayment of debt incurred in financing of the Alcan acquisition. After net debt levels were reduced to less than US$5 billion in 2010, capital expenditure was progressively increased between 2011 and 2012 in line with the stronger commodity prices. The weaker commodity price period between 2013 and 2016 witnessed a progressive decrease in capital expenditure. The average capital expenditure as a percentage of operational costs over the 17 year period was 23%, which compares to 21% and 34% for Anglo American and BHP respectively.

6.6 Distributions to shareholders

In 2017 Rio Tinto's formal dividend policy aimed to progressively increase the size of dividend pay-outs, without cutting dividends during periods of weak commodity prices (Rio Tinto, 2017). Figure 6.9 indicates the total distribution of capital to shareholders, which includes both dividends and share buy-backs, as a percentage of total revenue relative to the basket commodity price index.

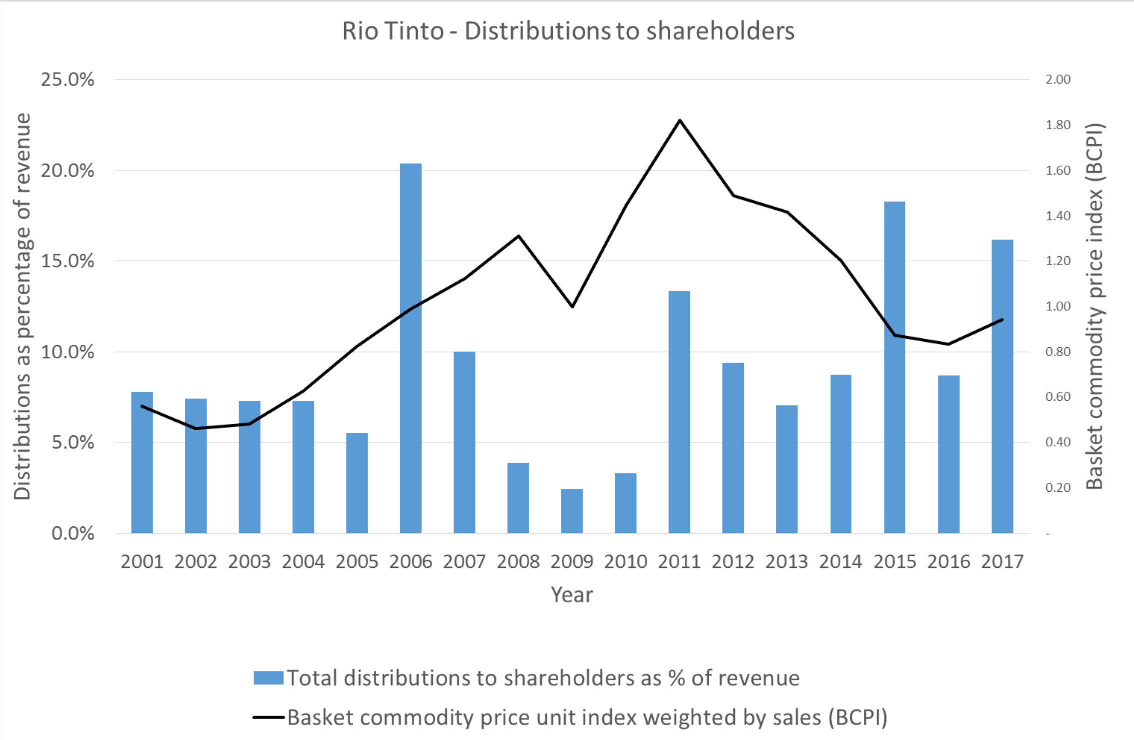

Figure 6.9: Rio Tinto distributions to shareholders for the period 2001 to 2017

From 2001 and 2010 there was a progressive weakening of total distributions to shareholders, from 7.8% of revenue in 2001 to 2.4% of revenue in 2010. The only exception was 2006 when a significant share buy-back programme was announced on the basis of strong operational cash flows. The reduction in distributions from 2008 to 2010 was due to the repayment of debt following the Alcan Inc. acquisition in 2007. Since 2010 there was a steady increase in total distribution to shareholders to 16.2% of revenue in 2017. The increase in distributions was made possible through a change in capital allocation strategy directing less capital to growth projects which enabled more consistent dividend pay-outs and share buy-back schemes (Rio Tinto, 2017).

6.7 Balance sheet strength

Rio Tinto indicated that in 2017 it had one of the strongest balance sheets of the diversified large mineral producers, with a net debt at end 2017 of US$3.8 billion. (Rio Tinto, 2017). This is reflected in Figure 6.10 where it can be seen that Rio Tinto is well positioned to cover its debt obligations with average cash flow to net debt coverage ratios in excess of three at end 2017.

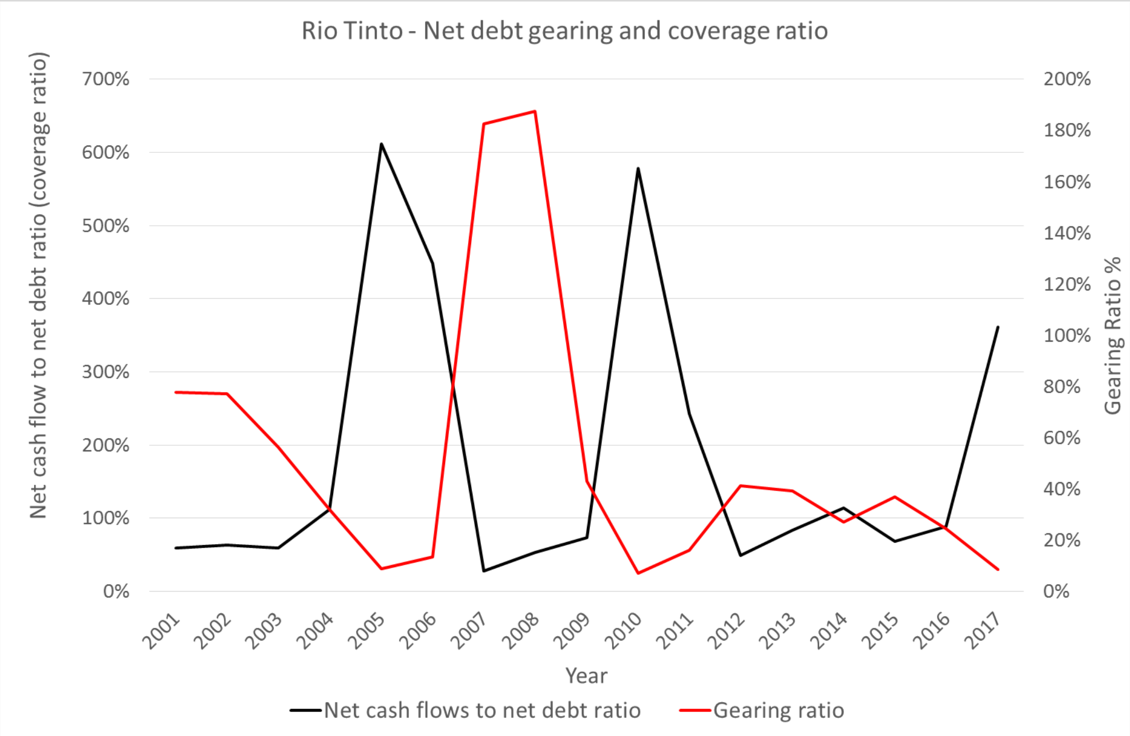

Figure 6.10: Rio Tinto net cash flows to net debt ratios

Rio Tinto's stated strategic objective is to preserve their strong balance sheet through disciplined allocation of capital (Rio Tinto, 2017). The impact of the significant acquisition of Alcan in 2017 is clearly visible in Figure 6.10 where the net gearing ratio significantly increased from 13% in 2006 to 182% in 2007. Strong operational performances in 2008 and 2009, together with a more stringent capital allocation process allowed Rio Tinto to significantly reduce the gearing ratio between the year 2007 and 2010. The gearing ratio since 2010 has remained less than 40% due to the use of a more disciplined capital allocation process.

6.8 Use of debt to finance capital commitments

The split between investments and repayment of debt is provided in Figure 6.11 which indicates a positive correlation between investment value and debt levels.

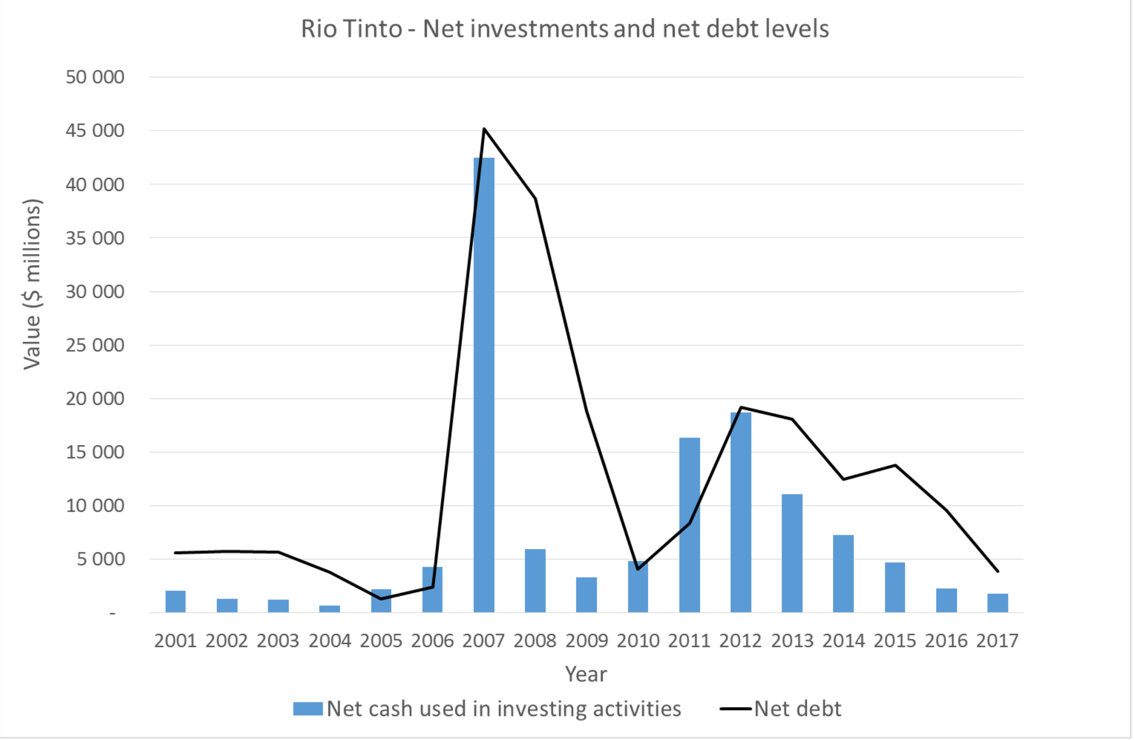

Figure 6.11: Rio Tinto split between net debt and net investments for the period 2001 to 2017

The positive correlation between net debt and net investments is evident in Figure 6.11 which indicates that Rio Tinto made extensive use of debt to finance its investments. During 2001 to 2006 the total net debt value remained relatively constant, after which it dramatically increased in 2007 following the Alcan Inc. acquisition. There were further increases in net debt levels in 2011 and 2012 due to capital expenditure on growth projects, with a subsequent decrease in net debt levels from 2013 to 2017 following the change in capital allocation strategy in 2013.

6.9 Impairments

Figure 6.12 illustrates Rio Tinto's historical capital allocation and impairments relative to the basket commodity price unit index.

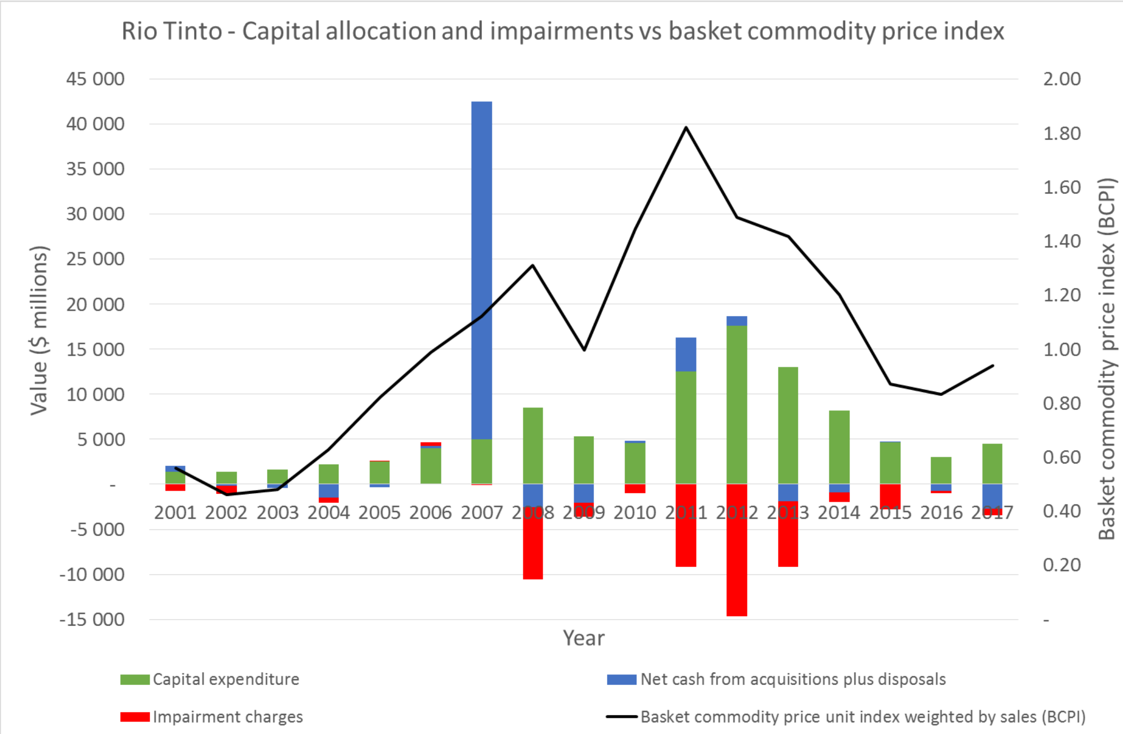

Figure 6.12: Rio Tinto historical capital allocation and impairments

Notably, significant capital amounts were allocated to expansionary projects from 2011 to 2013. Of these expansionary projects the largest project approvals were the Oyu Tolgoi copper and gold project in Mongolia, and the expansion of the Pilbara iron ore operations in Western Australia. During the same period impairments of a total value of US$31.2 billion were announced. Table 6.2 provides a breakdown of the total capital allocated and total impairments from 2001 to 2017.

Table 6.2: Total net investments by Rio Tinto during 2001 to 2017

Description	Unit	Value	% of total net investment
Total net investment from 2001 to 2017	**$ millions**	**130 578**	**100%**
Total capital expenditure from 2001 to 2017	$ millions	100 090	77%
Total acquisitions from 2001 to 2017	$ millions	45 713	35%
Total disposals from 2001 to 2017	$ millions	-15 225	-12%
Total impairments from 2001 to 2017	$ millions	-48 568	-37%

Similar to Anglo American and BHP, Rio Tinto allocated significantly more capital to expansionary and stay-in-business capital when compared to capital spent on acquisitions. Total impairments of US$48.6 billion was made from 2001 to 2017 which represents 37% of the invested capital during this period. This is the worst impairment ratio of the five companies analysed. The largest impairments were made in 2013 with US$11 billion impairment raised against Rio Tinto's aluminium assets, and US$3 billion impairment against the Rio Tinto Coal Mozambique assets. The significant value of impairments in 2013 directly contributed to the replacement of Rio Tinto's CEO in 2013 (Rio Tinto, 2013).

6.10 Return on capital employed

ROCE in relation to net capital allocated to investment activities as a percentage of operational costs and the basket commodity price index are shown in Figure 6.13. The data points contained in Figure 6.13 are provided in Appendix 11.19.

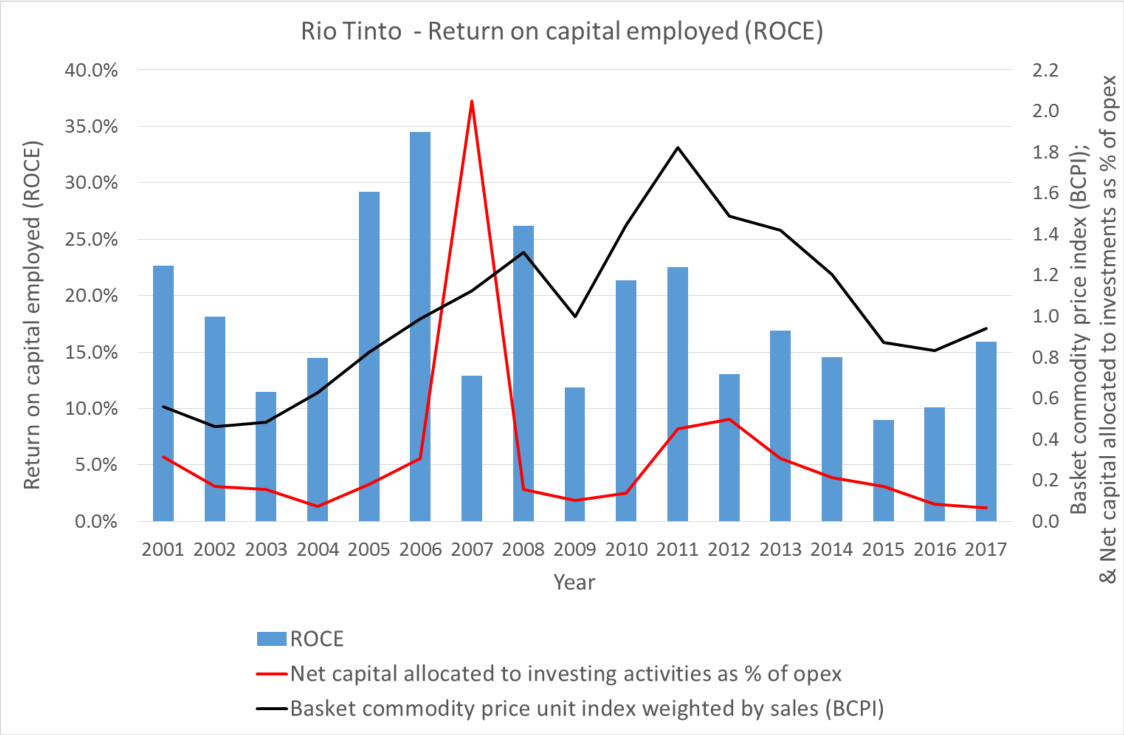

Figure 6.13: Rio Tinto ROCE for the period 2001 to 2017

The Alcan Inc. acquisition is visible in Figure 6.13 in the increase in net capital allocated to investment activities in 2007. There is a weak positive linear relationship between ROCE and the prevailing commodity prices with a Pearson correlation coefficient of 0.15, which is surprising as commodity prices normally have a high influence on ROCE. The low correlation can potentially be attributed to the influence of the significant acquisition cost of Alcan Inc. in relation to the enterprise value of Rio Tinto at the time of the acquisition. Figure 6.13 indicates a very weak negative linear relationship between net capital allocated to investment activities as a percentage of operational costs and ROCE, with a Pearson correlation coefficient of -0.10. ROIC in relation to net capital allocated to investments and the basket commodity price index are shown in Figure 6.14.

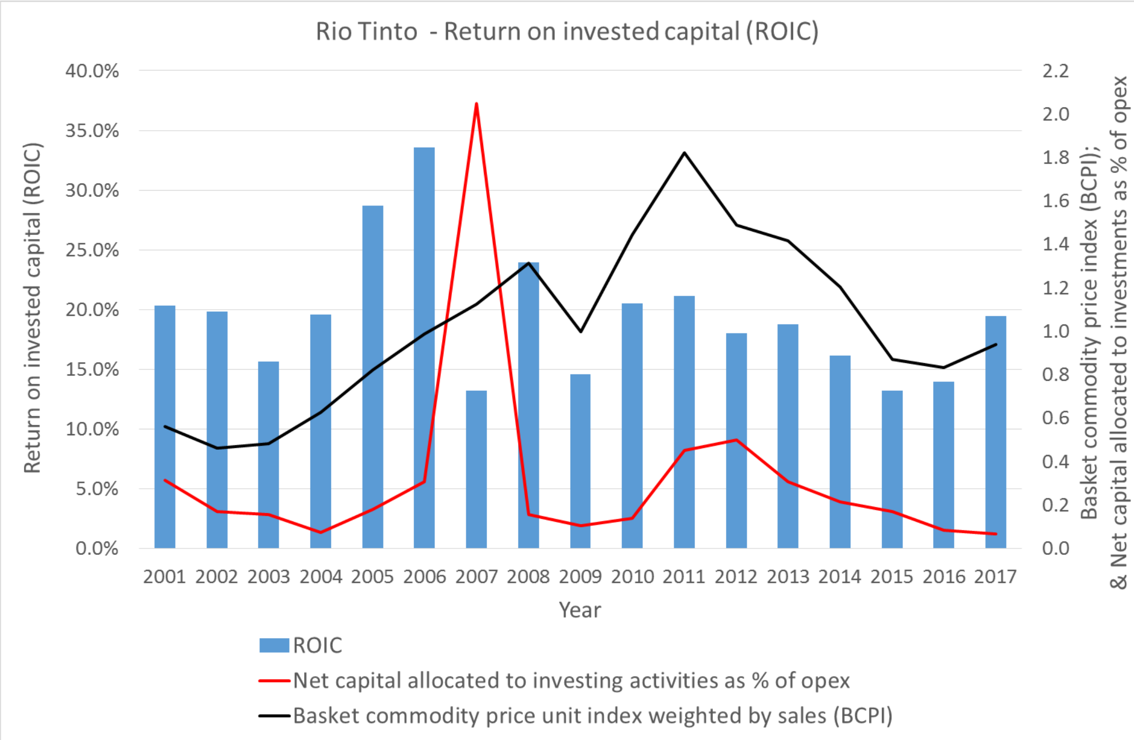

Figure 6.14: Rio Tinto ROIC for the period 2001 to 2017

Similar to the results obtained for ROCE, a very weak positive linear relationship was obtained between ROIC and the basket commodity price index, with a Pearson correlation coefficient of 0.06. This low correlation coefficient indicates no correlation between ROIC and the basket commodity price index. This result is unexpected and can potentially be due to the influence of the significant Alcan Inc. acquisition. Figure 6.14 also indicates a weak negative linear relationship between net capital allocated to investment activities as a percentage of operational costs and ROIC, with a negative Pearson correlation coefficient of -0.23. The low correlation is indicative that the amount of capital invested had little impact on the return on invested capital.

6.11 Hypothesis test

Figure 6.15 indicates ROIC relative to CIPCI. Figure 6.15 aims to test the hypothesis that timing of capital allocation decisions in relation to the prevailing commodity prices has an influence on the returns realised on the capital expenditure.

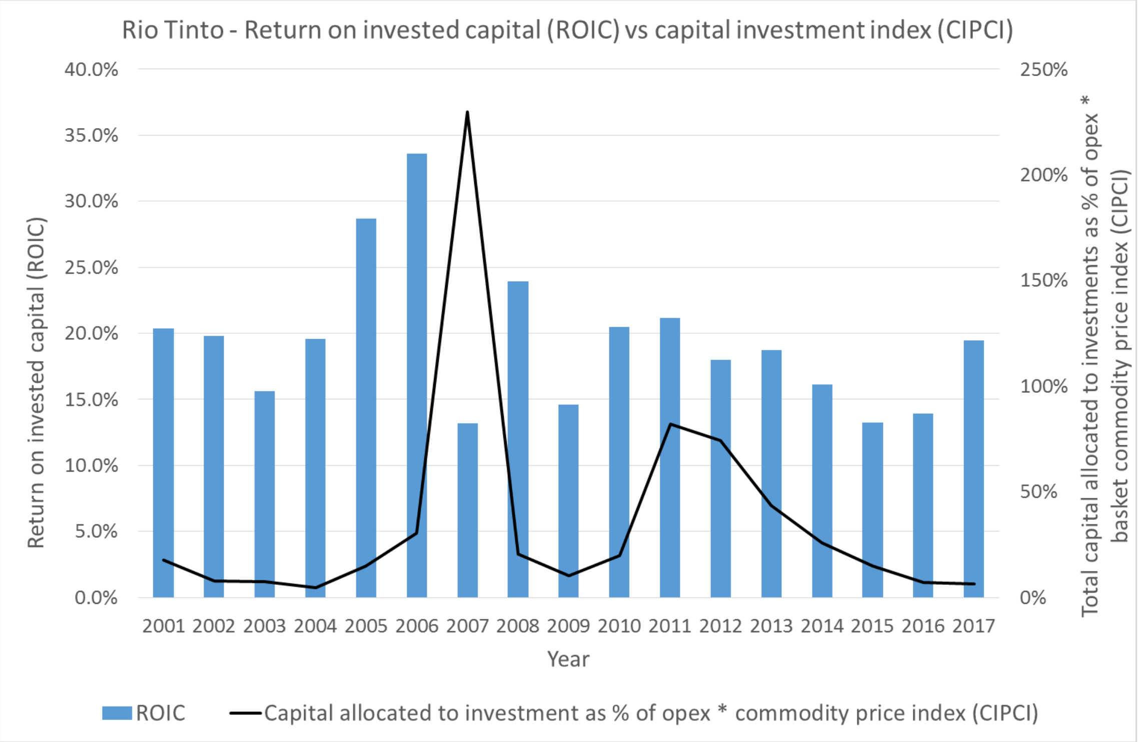

Figure 6.15: Rio Tinto ROIC as a function of CIPCI for the period 2001 to 2017

Figure 6.15 indicates a weak negative linear relationship between the ROIC and CIPCI. Similar to Anglo American and BHP, Figure 6.15 shows a high variability in CIPCI index which indicates that typically Rio Tinto did not follow a contrarian investment approach where capital expenditure is increased during periods of lower commodity prices, and vice versa. In order to test the linear relationship between ROIC and CIPCI a scatter diagram was developed for ROIC and CIPIC as shown in Figure 6.16.

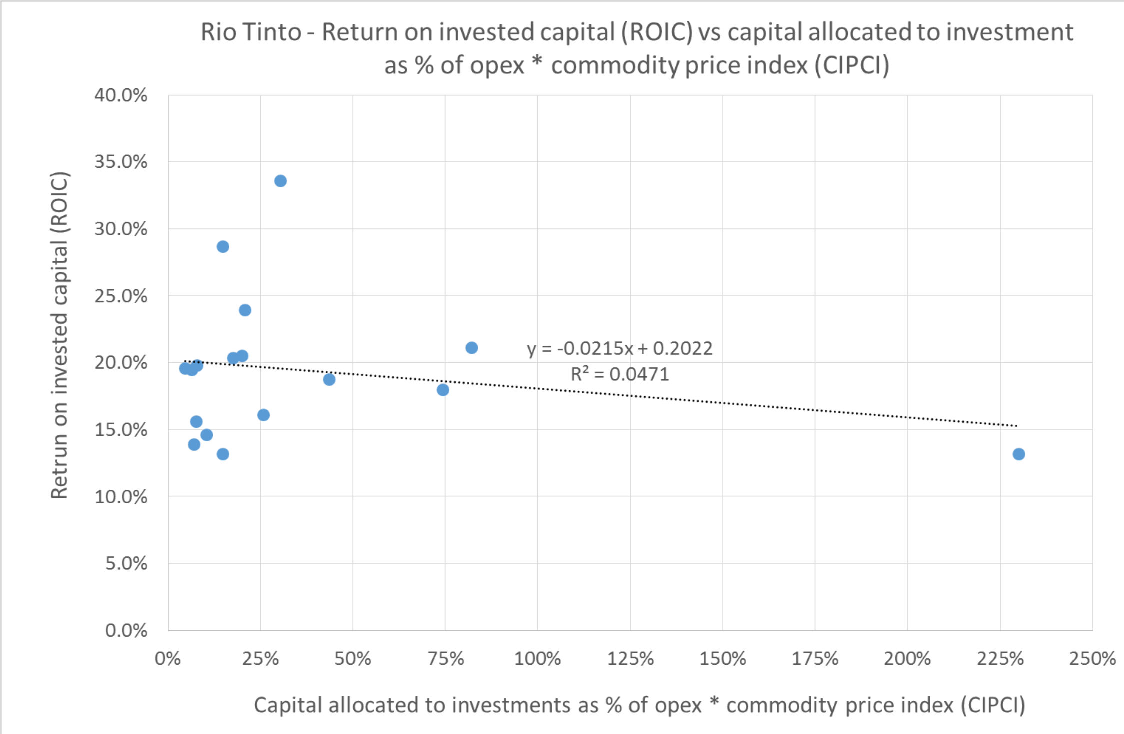

Figure 6.16: Rio Tinto - scatter diagram of ROIC and CIPCI for the period 2001 to 2017

Figure 6.16 indicates a weak linear relationship between ROIC and CIPCI. The coefficient of determination (R^2) is 0.05 which means that only 5% of the ROIC can be explained by CIPCI. The Pearson correlation coefficient is 0.22 indicating a weak positive linear relationship. Figure 6.17 illustrates ROCE in relation to CIPCI, and in Figure 6.18 a scatter diagram was used to test the linear relationship between ROCE and CIPCI.

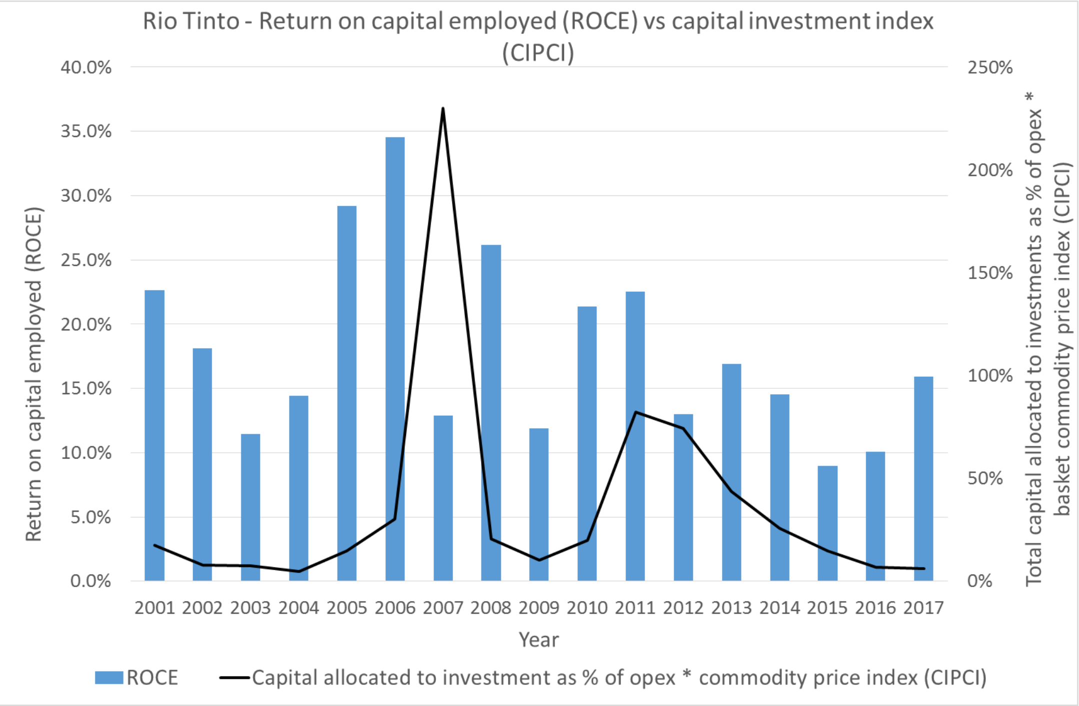

Figure 6.17: Rio Tinto ROCE as a function of CIPCI for the period 2001 to 2017

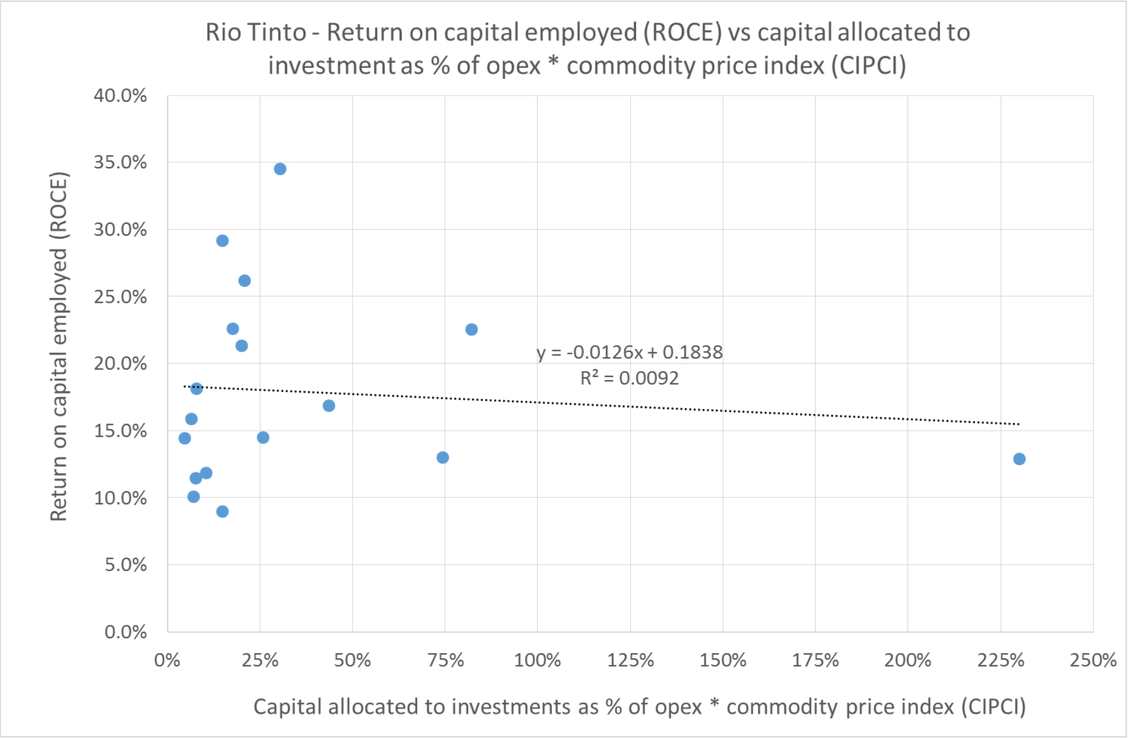

Figure 6.18: Rio Tinto – scatter diagram of ROCE and CIPCI for the period 2001 to 2017

Figure 6.17 and Figure 6.18 indicates a very weak negative linear correlation between ROCE and CIPCI, with a coefficient of determination (R^2) of 0.009. This indicates that less than one percent of the ROCE can be explained by CIPCI. The Pearson correlation coefficient between CIPCI and ROCE is -0.096, indicating a very weak negative linear relationship between CIPCI and ROCE. In order to account for the time lag between capital expenditure and return on investment, in Figure 6.19 CIPCI was compared to ROCE achieved three years after the capital investment was made. The linear relationship between ROCE achieved three years after the capital investment was made and CIPCI was evaluated with a scatter diagram shown in Figure 6.20.

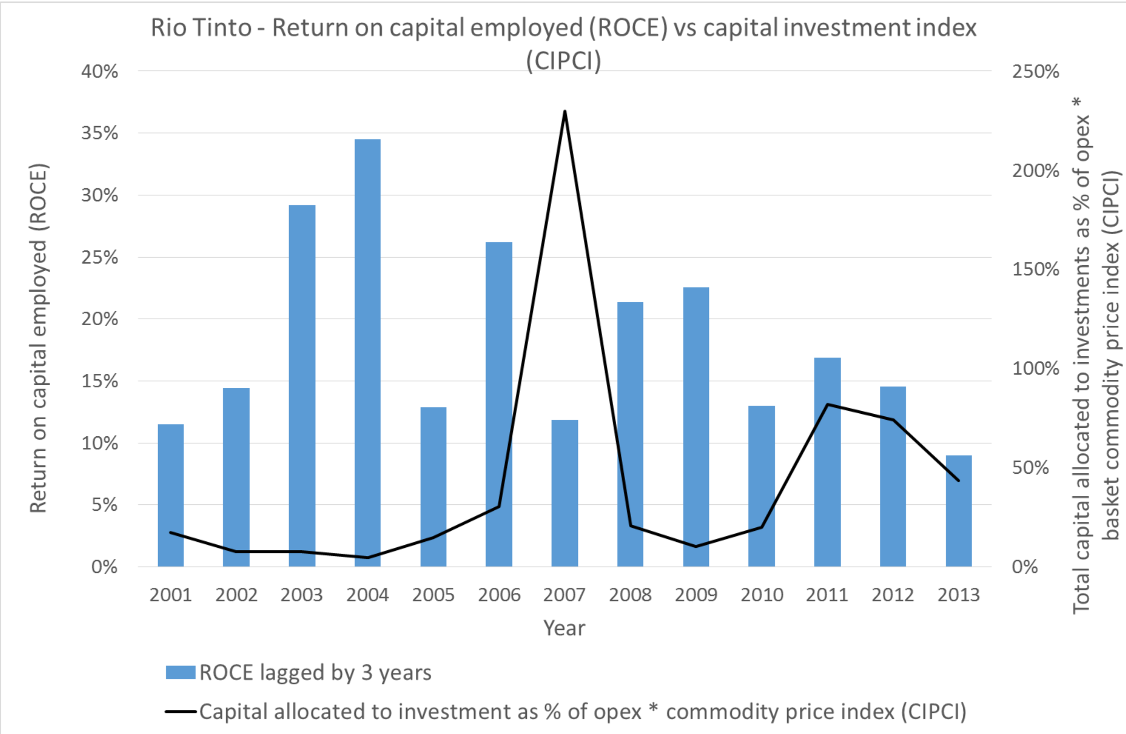

Figure 6.19: Rio Tinto ROCE lagged by 3 years as a function of CIPCI, 2001 - 2013

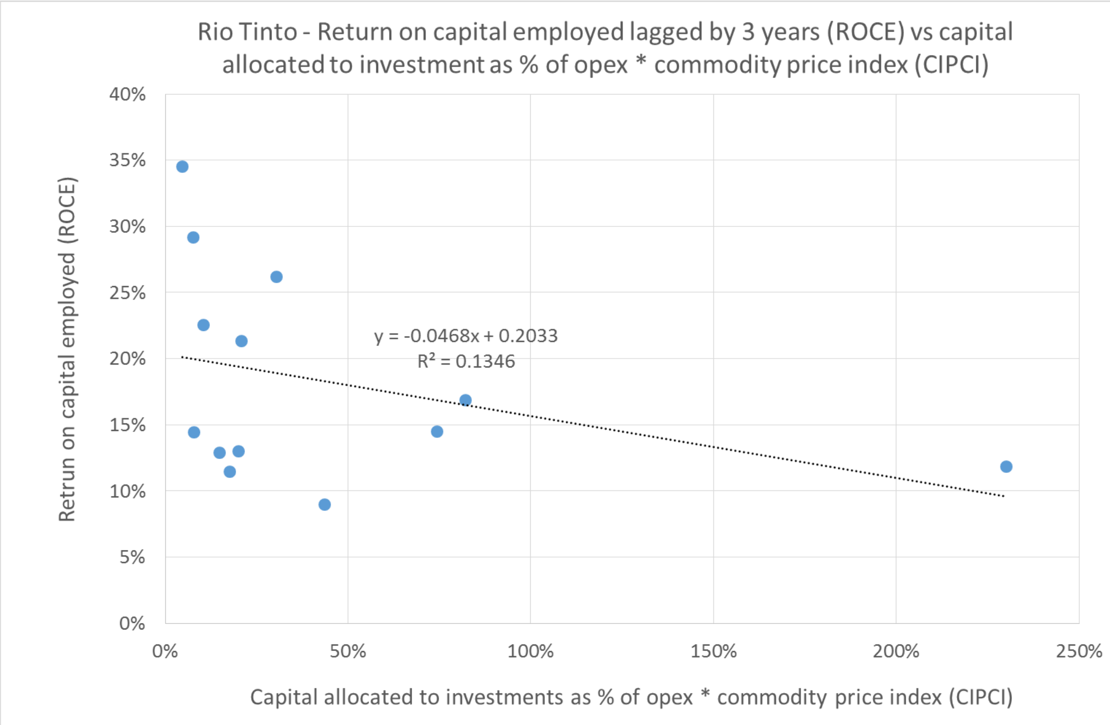

Figure 6.20: Rio Tinto – scatter diagram of ROCE lagged by 3 years and CIPCI, 2001 - 2013

Figure 6.19 and Figure 6.20 indicates a negative linear relationship between ROCE three years after the capital investment and CIPCI. The coefficient of determination (R^2) of 0.13 indicates that 13% of the variations in ROCE achieved three years after the investment can be explained by variations in CIPCI. The Pearson correlation coefficient of -0.37 indicates a moderate negative linear relationship. This indicates that capital allocated during high commodity prices typically achieved lower returns on capital invested three years after the investments were made. Conversely, capital allocated during periods of lower commodity prices typically achieved higher returns on capital invested three years after the investments were made.

6.12 Chapter summary

Rio Tinto produced a well-diversified mix of commodities with a relative even distribution of revenue split between the commodities. Rio Tinto managed to increase real term EBITDA by 267% between 2001 and 2017. This was primarily as a results of production volume growth as net operating margin remained relatively constant over the 17 year period.

In 2007 Rio Tinto completed a significant acquisition with the US$38.7 billion acquisition of Alcan Inc. The size of the Alcan acquisition was more than twice the value of Rio Tinto's shareholder's equity of US$18.2 billion at end 2006. From the year 2008 to 2010 there was a steady decrease in capital allocation to growth and stay-in-business as the focus was on decreasing debt used to fund the acquisition. Strong commodity prices in 2011 and 2012 contributed to increased capital allocation to growth projects during those periods. Similar to Anglo American and BHP there is a strong positive linear relationship between the relative strength of the prevailing commodity price and value of capital commitments, with a Pearson correlation coefficient of 0.86. The high correlation indicates that historically Rio Tinto allocated higher amounts of capital to growth initiatives during periods of high commodity prices.

Total impairments of US$48.6 billion was made over the analysis period which represents 37% of the invested capital. In 2011 to 2013 significant impairments were announced primarily relating to the Alcan acquisition and growth projects initiated in 2011. In a declining commodity price environment, from 2013 to 2017 the capital allocation focus shifted to maximising returns on capital employed and returning capital to shareholders. The increased focus on total shareholder returns, contributed to a reduction in capital allocated to expansionary capital expenditure and acquisitions.

As indicated in Figure 6.20 there is a moderate negative correlation between CIPCI and the return on investment achieved three years after the investment was made. This indicates that Rio Tinto typically obtained higher returns when capital is employed during relatively low commodity price environment. Capital invested during times of relatively high commodity prices had a higher probability of being impaired in a subsequent declining commodity price cycle. The results from the historical capital allocation analysis for Vale are provided and discussed in the next chapter.

7 ANALYSIS OF CAPITAL ALLOCATION BY VALE

7.1 Chapter overview

In this chapter the results from the research study on Vale are presented and analysed. The analysis of Vale followed the same process as the analysis conducted on Anglo American, BHP and Rio Tinto provided in Chapter 4, 5 and 6 respectively.

7.2 Historic capital allocation

Vale's historical allocation of capital to either building of new assets, purchase of new assets or returning capital to shareholders are provided in Figure 7.1. The terms build, buy, and return are as defined in sub-section 3.2.1. The data points contained in Figure 7.1 are provided in Appendix 11.25 and Appendix 11.26.

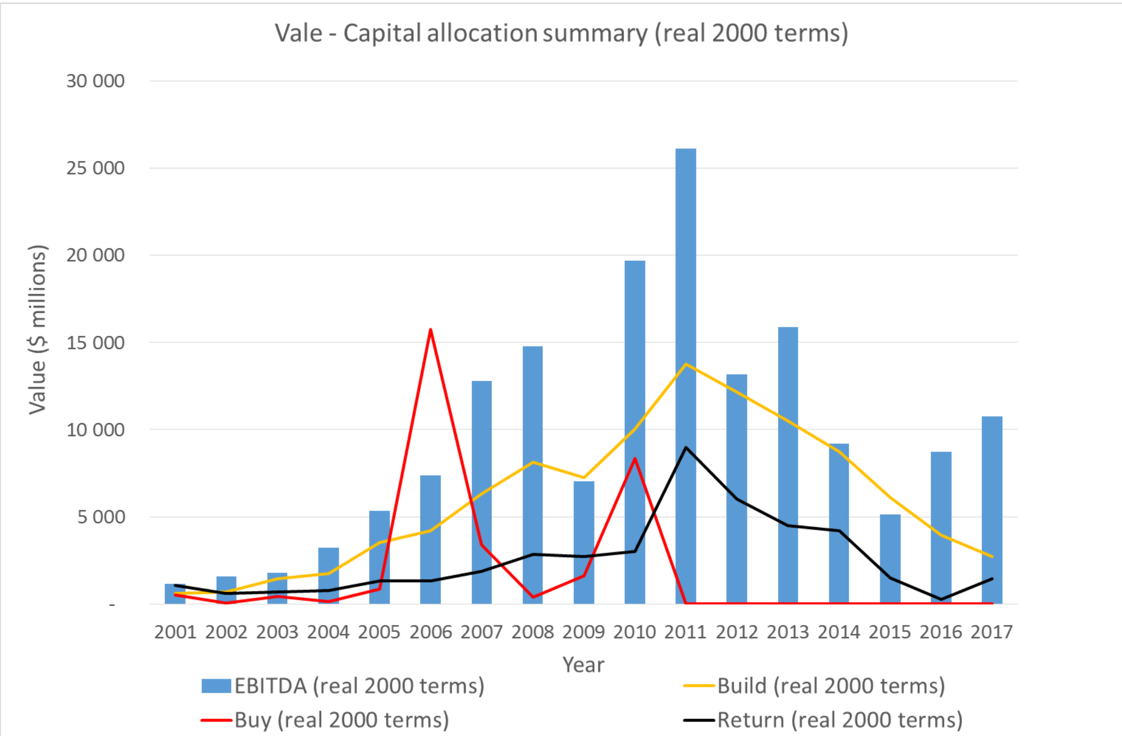

Figure 7.1: Vale summary of historical capital allocation for the period 2001 to 2017

From 2001 to 2011 Vale significantly increased the amount of capital allocated to building new mines, increasing from US$579 million to US$13.8 billion in real 2000 money terms. This is a similar to the results obtained for Anglo American, BHP and Rio Tinto. Strong increases in EBITDA between the years 2001 and 2011 allowed Vale to progressively increase the amount of capital returned to shareholders. EBITDA, return to shareholders, and capital allocated to build decreased progressively from 2012 to 2017 due to declining commodity prices. Notably, in 2006 Vale allocated US$17.1 billion for the acquisition of 87% of Inco's ordinary shares. At the time of the acquisition Inco was one of the world's largest nickel producers. This was done as part of a strategy by Vale to diversify its portfolio of commodities produced (Vale, 2006). The Inco purchase made Vale a major nickel producer, in addition to its dominant position in iron ore production. The major capital allocation decisions made by Vale over the analysis period are summarised below (Vale, 2001 – 2017):

- Figure 7.1 shows a steady increase in the build graph between 2001 and 2011. This increase in the build graph was due to a progressive increase in value of expansion projects approved. The major capital approvals during this period are summarised below:
    - ➢ In 2003 approval was given for the expansion of Carajás iron ore mine with a total capital cost of US$296 million;
    - ➢ During 2004 an investment of US$875 million was approved for the construction and development of the Verhelmo nickel mine with a nickel production capacity of 45,000 tonnes nickel per annum;
    - ➢ In 2005 an investment amount of US$366 million was approved for the expansion of Carajas iron ore mine to a combined capacity of 100 million tonnes per annum;
    - ➢ During 2006 a number of expansion project approvals were made. The expansion of the Carajas iron ore mine's combined capacity from 100mtpa to 130mtpa was approved with a total cost of US$1,828 million. The project approval of the US$855 million

Salobo copper mine was given during 2006. The Salobo copper mine was approved with a production capacity of 100,000 tonnes copper per annum. Development of the Onça Puma nickel mine was approved in 2006. The mine was approved with an annual nickel production capacity of 58,000 tonnes. The capital cost of the approved project was US$1,437 million. The Verheldo nickel mine development was approved in 2006 with a total capital cost of US$1,452 million. The mine was approved on the basis of a 46,000 tonnes per annum nickel and 2,800 tonnes per annum cobalt production capacity. In 2006 the Goro nickel project was approved with a total capital cost of US$3,212 million. The project involved the construction of a mine and plant to produce 60,000 tonnes per annum refined nickel and 4,600 tonnes per annum cobalt;

- During the year 2007 a US$10.1 billion capital approval was made for the development Serra Sul iron ore mine. In addition the Litorânea Sul railroad required in support of the project was approved for US$414 million. During 2007 a US$10.1 billion capital approval was made for the development Serra Sul iron ore mine. In addition the Litorânea Sul railroad required in support of the project was approved for US$414 million. The project development of the US$2.2 billion Voisey Bay nickel refinery was approved in 2007;
- In 2008 Vale approved the US$2.5 billion development of the Apolo iron ore mine; and
- In 2010 a number of project approvals were made. Phase two of the Conceiçao Itabiritos iron ore mine was approved for US$1.2 billion. Approval was given for the US$2.1 billion Moatize coal expansion project. The Nacala Corridor project was approved for US$4.4 billion; and the Salobo phase two copper project was approved for US$1.0 billion.

- The significant increase in the buy graph in 2006 was due to the acquisition of 87% of Inco's ordinary shares for a total amount of US$17.1 billion. In January 2007 Vale acquired the remaining 13% of Inco for an amount of US$2.1 billion. This increased the total acquisition cost for 100% of Inco to US$19.2 billion;
- The increase in the buy graph in 2010 was due to the acquisition of the Brazilian phosphate operations of Vale Fertilizantes, for a total amount of US$5.83 billion. In addition a 51% interest in BSG Resources (Guinea) Limited was acquired in 2010. At the time BSG Resources held the Simandou South and North iron ore exploration permits. The total cost of the acquisition was US$2.5 billion;
- Due to weak commodity prices in the year 2014 Vale announced a number of disposals to Mitsui & Co., Ltd. as listed below:
  - 62.4% sale of logistics company VLI for R$1.5 billion;
  - Sale of 15% equity stake in Moatize coal operation for US$450 million; and
  - Sale of 50% of the Nacala Corridor for US$313 million.
- A substantial part of Vale's fertilizer business was sold in 2016 to Mosaic for a total amount of US$2.5 billion.

Analysis of the major capital allocation decisions made by Vale over the analysis period reveals a similar pattern to Anglo American, BHP and Rio Tinto. Significant amounts of capital were allocated to growth initiatives during periods of high commodity prices, and conversely disposal of assets were made during periods of weak commodity prices. Figure 7.2 provides a more detailed analysis of the historical capital allocation over the analysis period, split between stay-in-business capital expenditure, expansion capital expenditure, acquisitions and disposals and total capital returns to shareholders. Figure 7.2 also shows the net cash flows from operating activities as a percentage of revenue, and the basket commodity price index. The data points contained in Figure 7.2 are provided in Appendix 11.25 and Appendix 11.26.

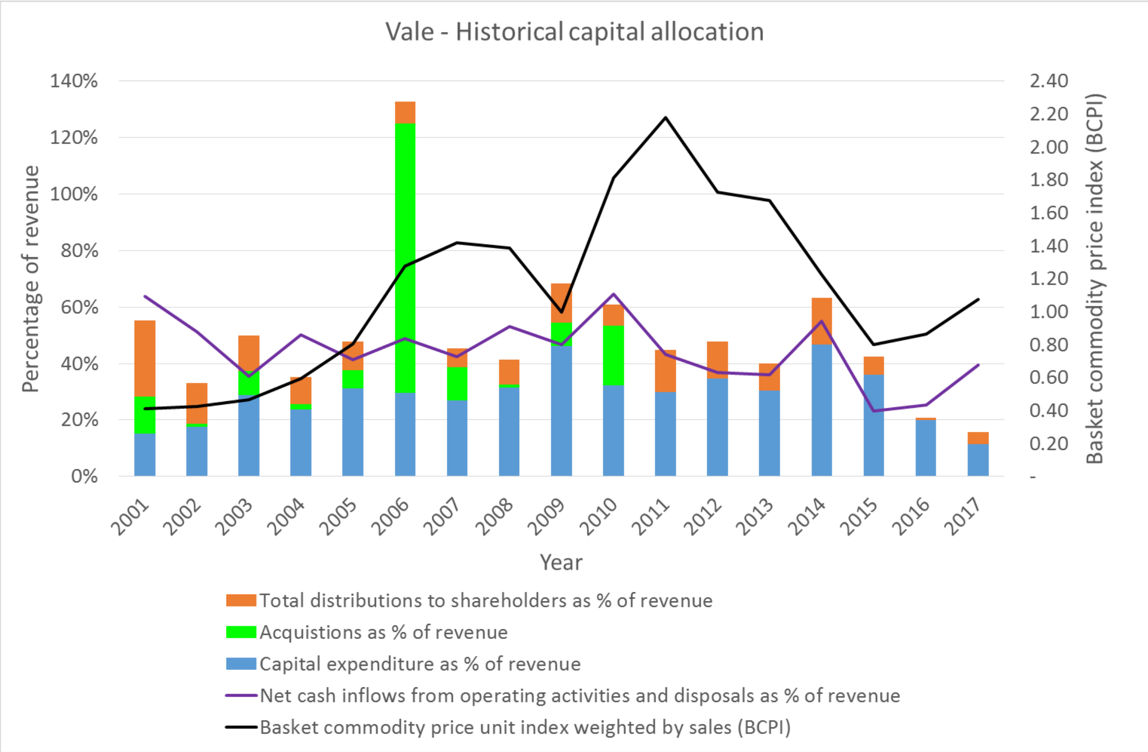

Figure 7.2: Vale summary of historical capital allocation for the period 2001 to 2017

The stand-out acquisition was Inco Limited in 2006 with a combined value of US$19 billion. Figure 7.2 indicates a steady allocation of capital expenditure over the analysis period. The consistent allocation of capital expenditure allowed Vale to maintain a net operating margin equal to circa 40% of revenue. This is indicated in Figure 7.2 where net cash inflows from operating activities ranged between 20% and 60% of revenue, with an average of circa 40% of revenue.

7.3 Overview of historical financial performance

An overview of the financial performance of Vale over the analysis period is provided in Figure 7.3 in which total revenue, total capital expenditure, total operational costs and EBITDA are provided in real 2000 terms.

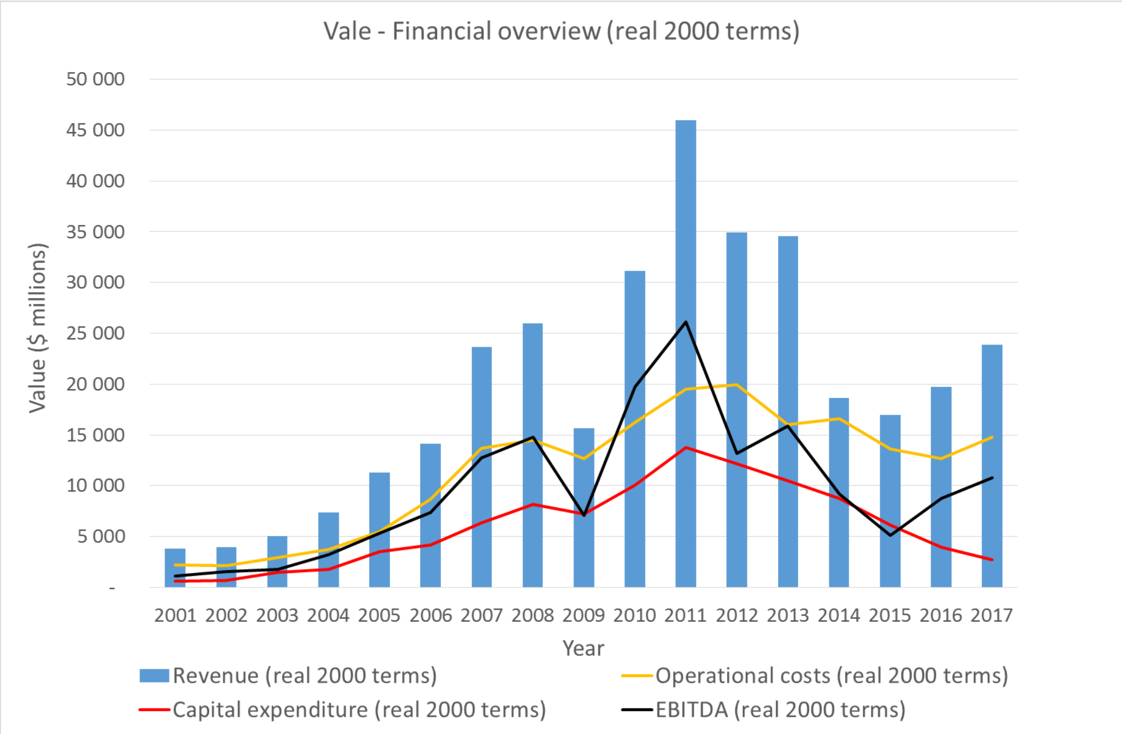

Figure 7.3: Financial overview of Vale for the period 2001 to 2017

Similar to BHP and Rio Tinto, Vale achieved significant increases in revenue between 2001 and 2011. Figure 7.3 indicates a positive year-on-year increase in revenue between 2001 and 2011 with a positive CAGR of 28.2%. This increase in revenue was made possible by progressive increases in capital expenditure. From 2012 to 2016 revenue decreased by an average negative annual growth rate of -22.0% due to a decline in commodity prices. Operational costs also progressively increased above inflation rates from 2001 to 2011. However, Vale was successful in achieving higher year-on-year increases in revenue in relation to operational costs, which allowed Vale to increase EBITDA by 844% in real 2000 terms between 2001 and 2017. This represents an average real term CAGR of 15.1%.

7.4 Revenue and production volume growth

Vale's revenue in real 2000 terms derived from commodities produced over the analysis period is shown in Figure 7.4. The data points contained in Figure 7.4 are provided in Appendix 11.28 to Appendix 11.32.

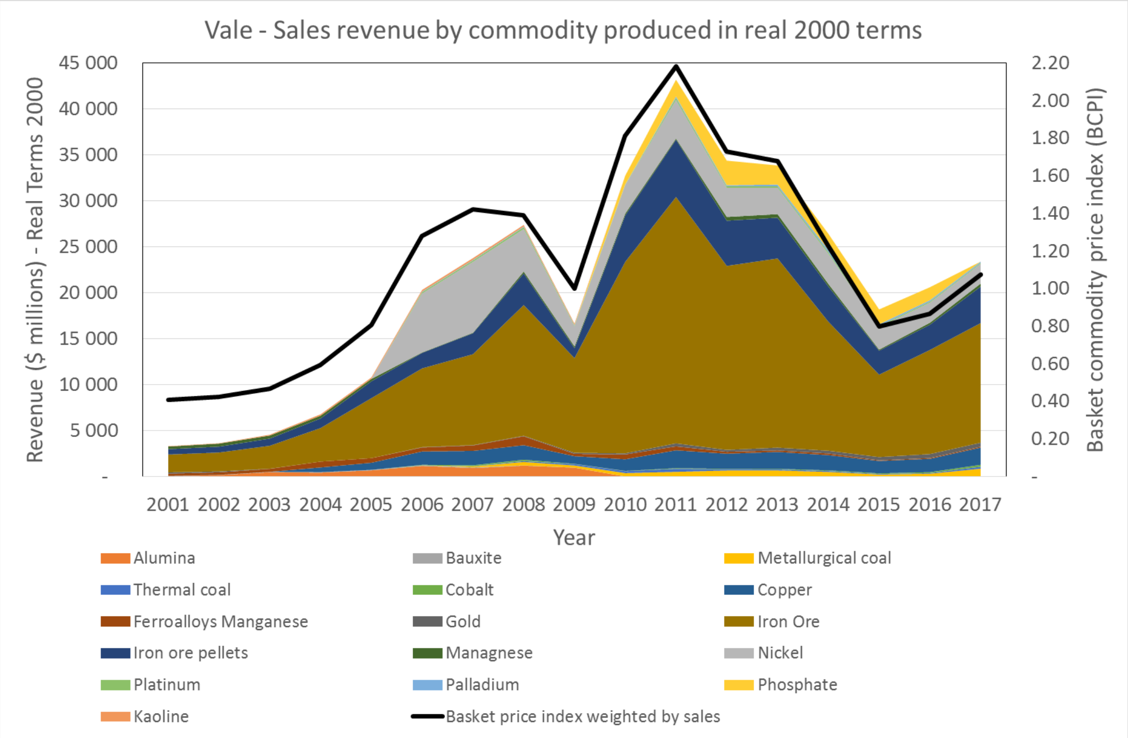

Figure 7.4: Vale revenue from commodities production in real 2000 terms

Figure 7.4 indicates that revenue was predominantly derived from iron ore sales which contributed 72.7% of overall sales in 2017. Figure 7.4 shows a perfect positive linear relationship between total revenue and the weighted average basket price index with a Pearson correlation coefficient of 0.95. This perfect positive correlation is expected as commodity prices have a direct influence on revenue. Table 7.1 provides the percentage revenue split between commodities produced by Vale in the periods 2002, 2008, 2011 and 2017.

Table 7.1: Vale revenue split by commodity produced

Revenue split by commodity produced	Unit	2001	2008	2011	2017
Alumina	%	0.9%	4.3%	0.0%	0.0%
Bauxite	%	0.6%	0.1%	0.0%	0.0%
Metallurgical coal	%	0.0%	1.4%	1.1%	3.6%
Thermal coal	%	0.0%	0.3%	0.8%	0.9%
Cobalt	%	0.0%	0.5%	0.2%	0.9%
Copper	%	0.0%	5.7%	4.5%	8.0%
Ferroalloys Manganese	%	7.5%	3.5%	1.0%	0.4%
Gold	%	4.0%	0.2%	0.8%	1.8%
Iron Ore	%	57.9%	51.5%	61.8%	55.7%
Iron ore pellets	%	17.3%	12.5%	14.4%	17.0%
Managnese	%	8.5%	0.8%	0.3%	1.4%
Nickel	%	0.0%	16.8%	9.7%	9.2%
Platinum	%	0.0%	0.8%	0.5%	0.4%
Palladium	%	0.0%	0.2%	0.3%	0.6%
Phosphate	%	0.0%	0.0%	4.2%	0.0%
Potash	%	2.1%	0.9%	0.5%	0.0%
Kaoline	%	1.2%	0.6%	0.0%	0.0%
Total	**%**	**100%**	**100%**	**100%**	**100%**
Number of commodities produced		**9**	**16**	**14**	**12**

Between 2001 and 2017 Vale increased the number of different mineral products produced from 9 to 12. This is in contrast to Anglo American, BHP and Rio Tinto where the strategic focus was to decrease the amount of commodities produced and only focus on a number of commodities considered to be of strategic importance. However, Vale's diversification strategy was only partially successful, with sales of iron ore and associated products in 2017 contributing 72.7% of total revenue, which was very similar to the 75.2% contribution from iron ore and associated minerals in 2001. In 2017 89.9% of total revenue was derived from only three commodities and their associated minerals, namely iron ore, nickel and copper. Figure 7.5 shows the growth in production volumes relative to the production volumes achieved in the year 2001.

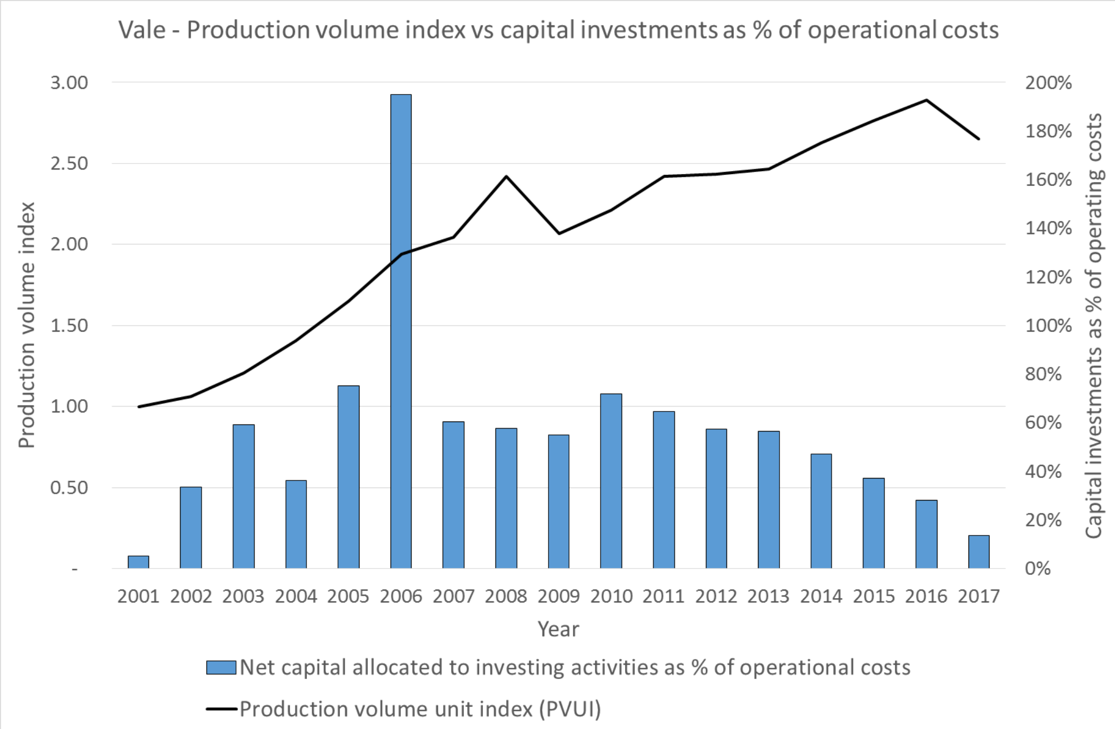

Figure 7.5: Vale production volume growth index for the period 2001 to 2017

Over the 17 year analysis period the production volume index progressively increased by 165% which is a CAGR of 6.3%. The high growth rates in the production volume unit index were made possible by a high percentage allocation of capital to growth activities, equal to 49% of the annual operational cost expenditure. Vale's capital allocation to investment activities as a percentage of operational costs far exceeds the circa 20% level required to sustain production levels as derived from the analysis on Anglo American.

7.5 Capital commitments and actual capital expenditure

Capital commitments towards SIB capital and expansionary capital in real 2000 terms, are indicated in Figure 7.6 relative to the basket commodity price index. Capital commitments represents the amount of capital committed to be spend either internally or with third parties through contractual or commercial agreements.

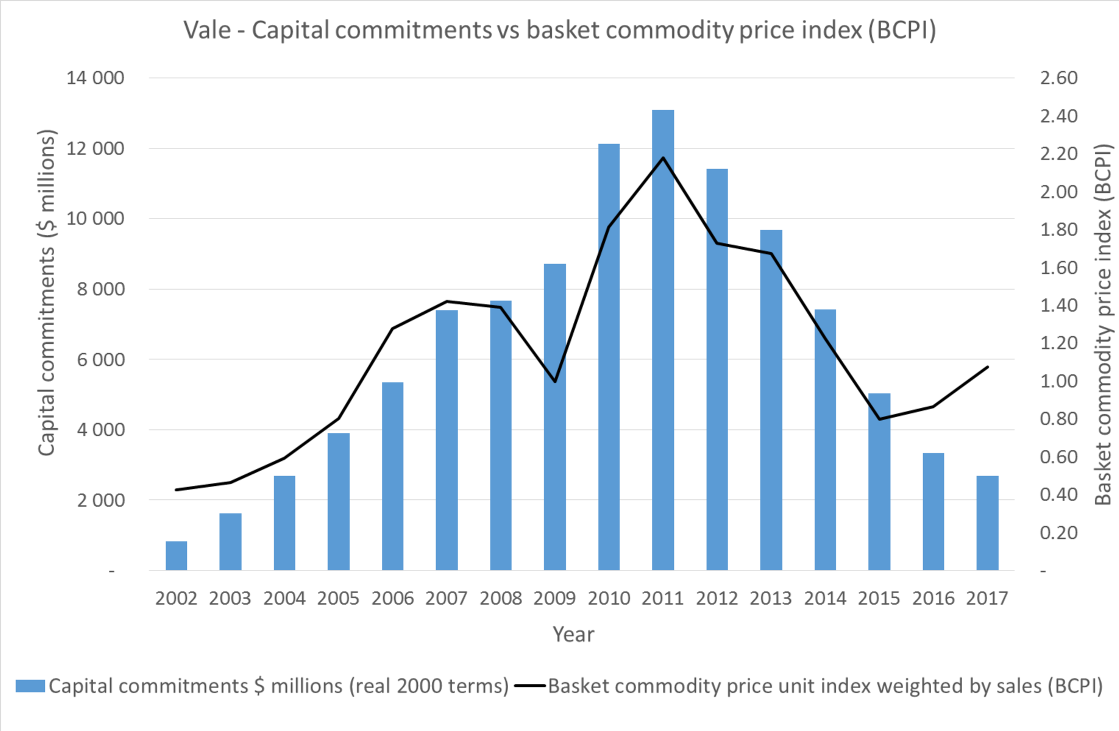

Figure 7.6: Vale capital commitments relative to prevailing commodity prices for the period 2001 to 2017

Similar to results for Anglo American, BHP and Rio Tinto, Figure 7.6 illustrates a positive linear relationship between the prevailing commodity price and value of capital commitments. The only exception is 2016 and 2017, where the capital commitments remained low notwithstanding an increasing commodity basket price. This was due to Vale focussing on repayment of debt in the period of low commodity prices in 2016 and 2017. In Figure 7.7 the linear relationship between the capital commitments and the prevailing commodity prices is represented in a scatter diagram.

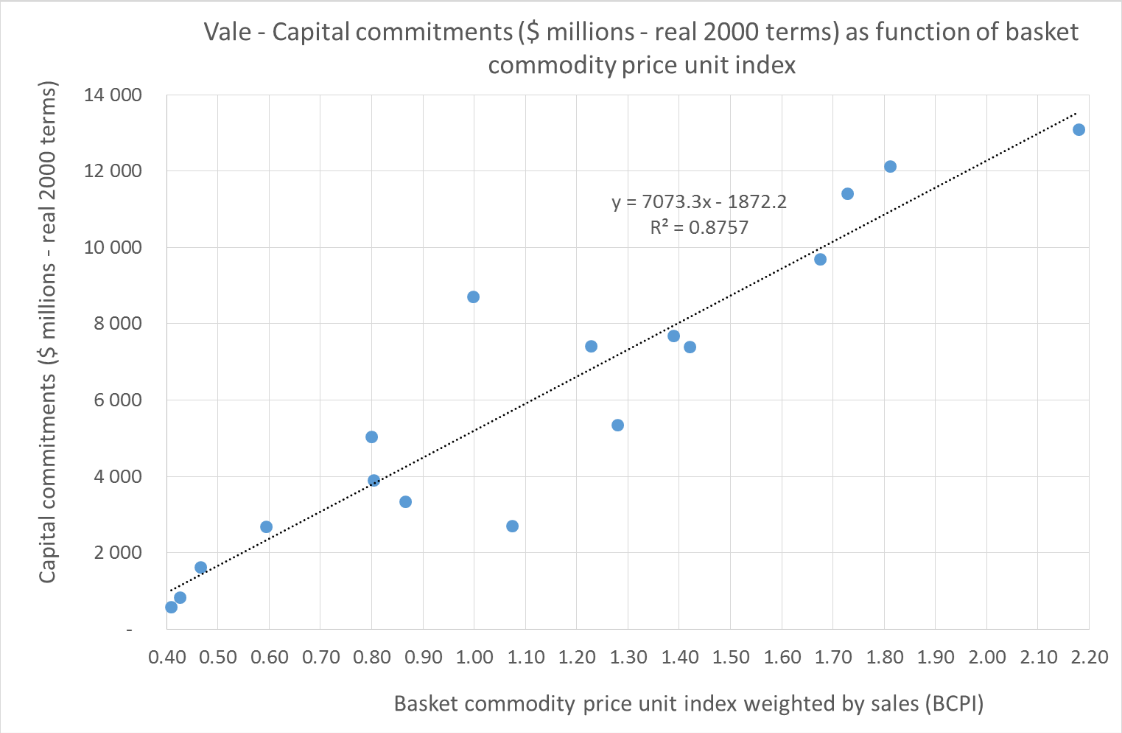

Figure 7.7: Vale - scatter diagram of capital commitments relative to prevailing commodity prices for the period 2001 to 2017

Figure 7.7 indicates a strong positive linear relationship between capital commitments and the prevailing basket commodity prices. The coefficient of determination (R^2) is 0.88, which means that 88% of the variations in the amount of capital allocated can be explained by variations in the prevailing basket commodity prices index. The Pearson correlation coefficient between the amount of capital allocated and the prevailing basket commodity prices index is 0.94. The actual capital expenditure as a percentage of operational costs relative and the basket commodity price index are indicated in Figure 7.8.

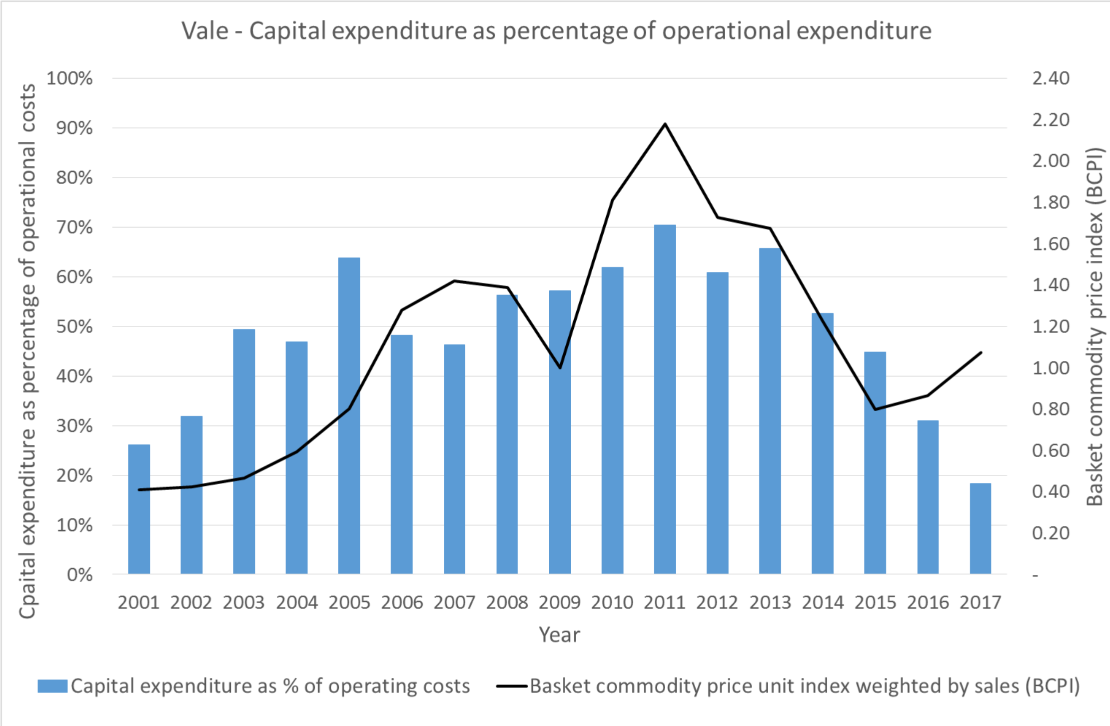

Figure 7.8: Vale capital expenditure as percentage of operational costs for the period 2001 to 2017

The capital expenditure as percentage of operational costs remained in the range of 50% to 70% for most of the analysis period. From 2015 to 2017 there was a progressive year-on-year drop in capital allocated to capital expenditure from 66% in 2013 to 18% in 2017. Vale's average capital expenditure as percentage of operations costs over the analysis period is equal to 49% of revenue. This is substantially higher than Anglo American, Vale and Rio Tinto whom typically committed amounts between 10% to 30% of annual operational costs to capital expenditure. The higher allocation of available funds to capital expenditure allowed Vale to achieve CAGR in shareholders' equity of 12.9% over the analysis period, compared to 1.6%, 6.6%, and 9.9% achieved by Anglo American, BHP and Rio Tinto respectively.

7.6 Distributions to shareholders

Vale indicated a strategic objective to reduce net debt levels to below US$10 billion from US$18.1 billion at the end of 2017 (Vale, 2017). From 2016 to 2017 Vale reduced net debt by US$6.9 billion, which bodes well for Vale to reach its stated target within the next couple of years. Vale stated that reaching the net debt target level will enable them to become a more predictable and consistent dividend payer to shareholders. Figure 7.9 indicates Vale's historical total distributions to shareholders as a percentage of revenue.

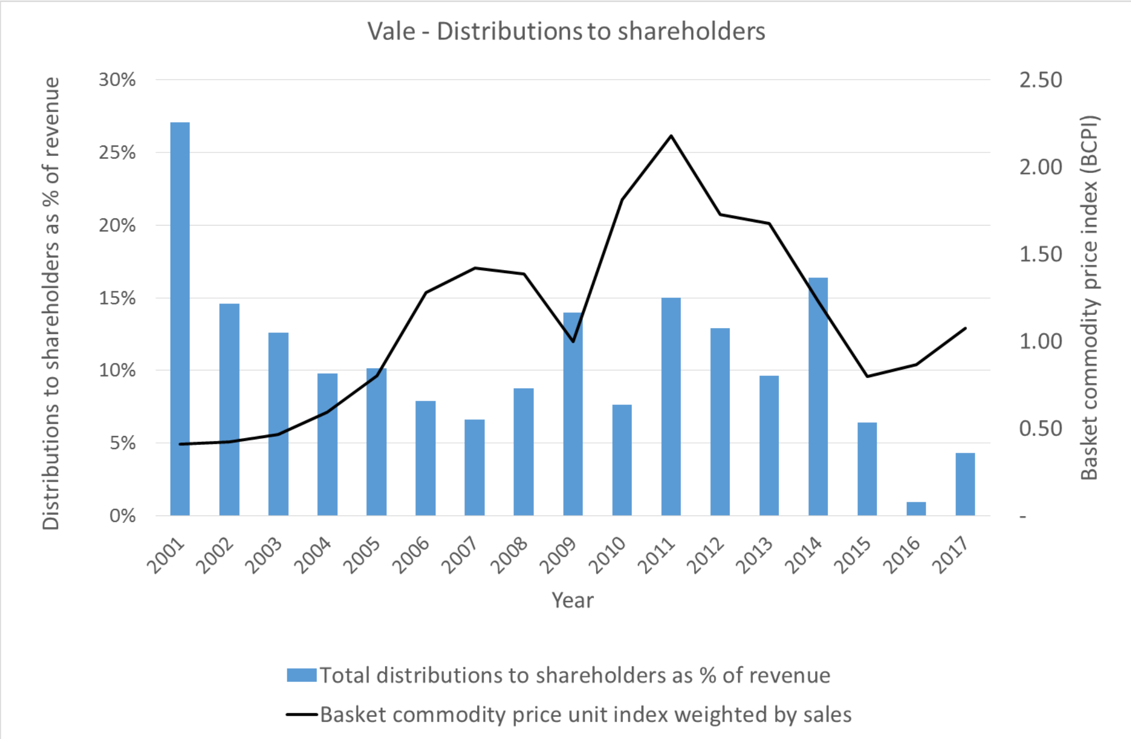

Figure 7.9: Vale distributions to shareholders for the period 2001 to 2017

Figure 7.9 indicates that Vale from 2001 to 2014 was able to distribute cash to shareholders ranging between 7% and 16% of revenue. From 2015 to 2017 distributions to shareholders were dramatically reduced to between 1% and 6% of annual revenue as Vale focussed on repayment of debt. Of interest is, with the exception of the years 2016 and 2017, Vale managed to consistently allocate distributions to shareholders throughout the commodity price cycle.

7.7 Balance sheet strength

In a growth orientated company such as Vale, balance sheet strength is one of the key considerations in the funding of the capital allocated towards growth initiatives. Figure 7.10 shows the net gearing ratio and net cash flow to net debt ratio (coverage ratio), which are indicators of Vale's balance sheet strength.

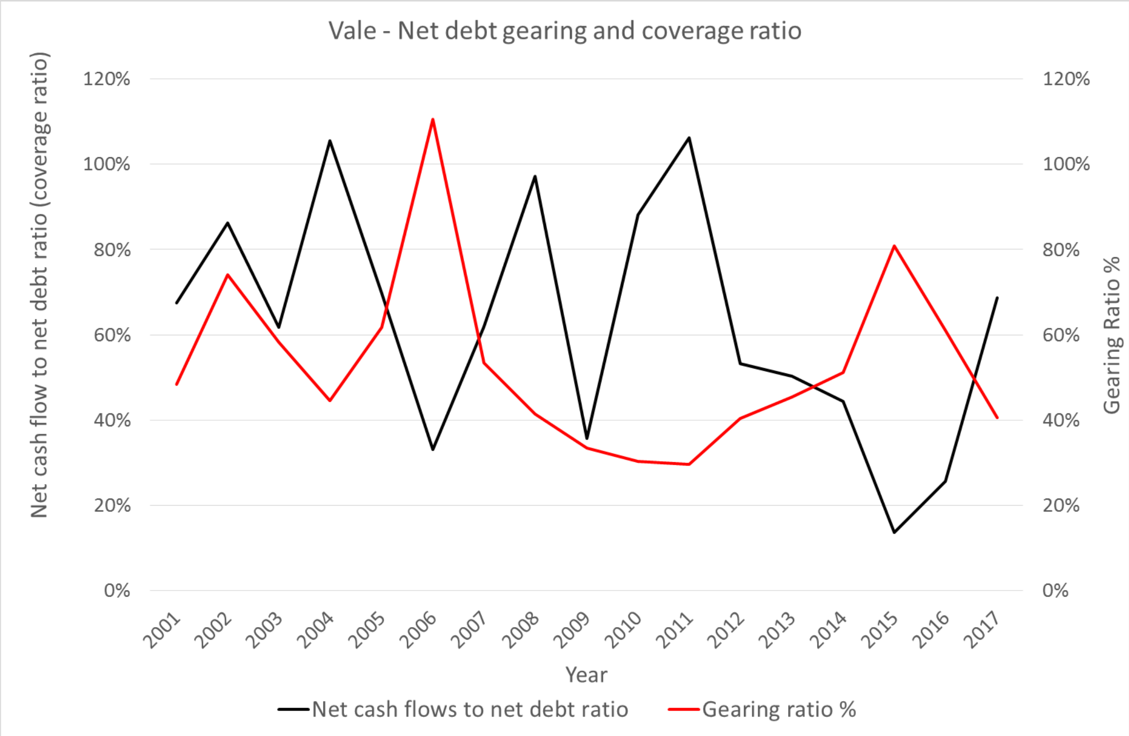

Figure 7.10: Vale net cash flows to net debt ratios for the period 2001 to 2017

Figure 7.10 indicates that Vale consistently made use of debt to finance the high capital expenditure relative to operational costs over the 17 year analysis period. The net cash flow to net debt levels remained in the range of 40% to 100% for most of the 17 year period, with the only exception being 2015 and 2016 with the drop in iron ore price. Of interest is the short term cyclical nature of the net cash flows to net debt ratios. This is indicative of Vale's strong operational performance over the period which allowed Vale to repay debt in a short duration after each capital investment. Figure 7.10 indicates that for most of the 17 year period Vale was well positioned to cover its debt obligations. In 2006 the net gearing ratio increased dramatically with the US$19 billion acquisition of Inco Limited, a Canadian nickel producer (Vale, 2006). However, due to strong cash flows from operations in subsequent years the net gearing ratio swiftly reduced from 111% in 2006 to 33% in 2009.

7.8 Use of debt to finance capital commitments

The split between investments and repayment of debt is provided in Figure 7.11 which indicates a positive correlation between investment value and debt levels.

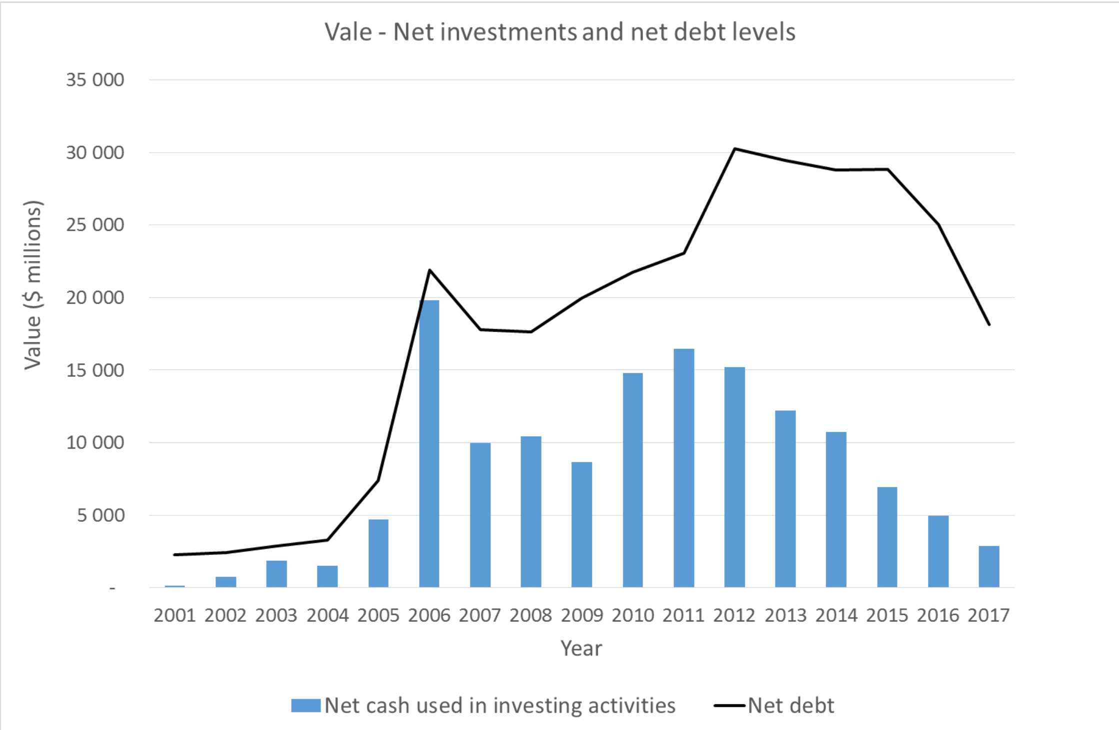

Figure 7.11: Vale split between net debt and net investments for the period 2001 to 2017

Figure 7.11 indicates that during 2001 to 2005 total net debt values remained relatively constant with a dramatic increase in 2006 following the Inco Limited acquisition. From 2007 to 2011 there was a progressive increase in net debt levels due to the approval of a number of capital projects. Net debt levels peaked at US$30.3 billion in 2012, and progressively decreased to US$18.1 billion in

2017. Vale stated it to be an objective to reduce net debt to less than US$10 billion (Vale, 2017).

7.9 Impairments

Figure 7.12 illustrates Vale's historical capital allocation and impairments relative to the basket commodity price unit index.

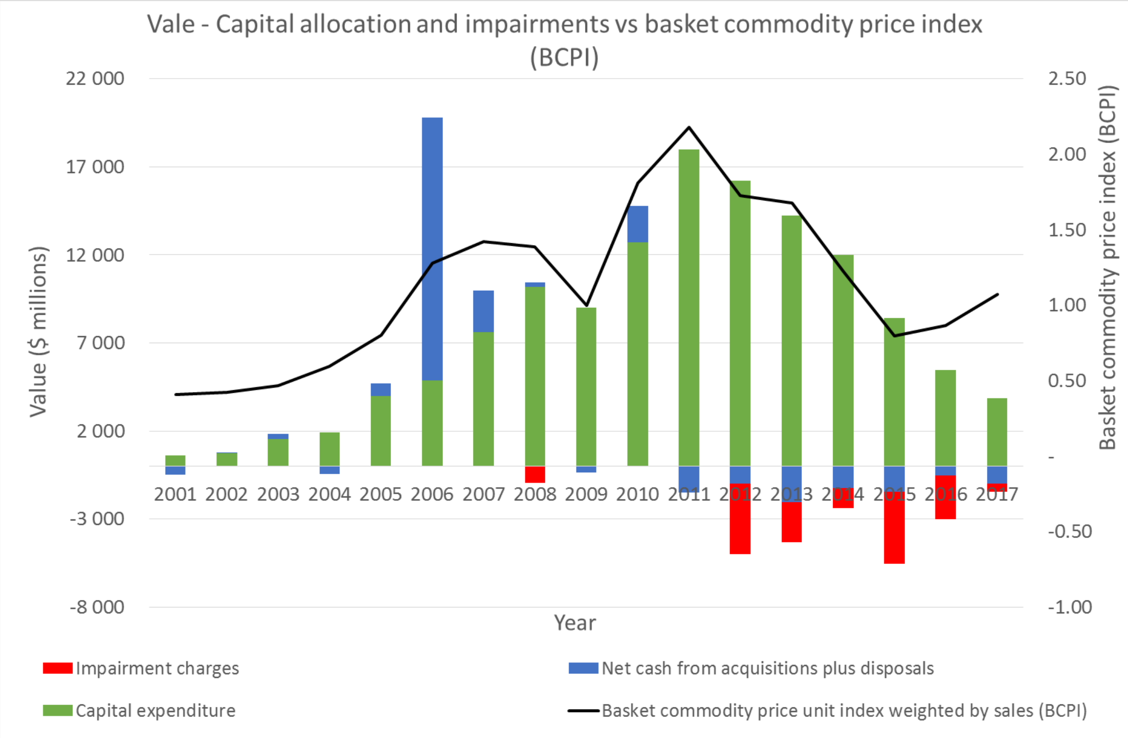

Figure 7.12: Vale historical capital allocation and impairments for the period 2001 to 2017

Similar to Anglo American, BHP and Rio Tinto, significantly more capital was allocated to expansionary capital expenditure, compared to capital allocated to acquisitions. The US$19.2 billion acquisition of Inco in 2006 is visible in Figure 7.12. A number of impairments were made in the years 2012 to 2017 due to declining commodity prices. Typically the impaired assets were approved for development during periods of high commodity prices, with the subsequent decline in commodity prices negatively impacting valuations. Table 7.2 provides a breakdown of the total capital allocated and total impairments from 2001 to 2017.

Table 7.2: Total net investments by Vale during 2001 to 2017

Description	Unit	Value	% of total net investment
Total net investment from 2001 to 2017	**$ millions**	**131 619**	**100%**
Total capital expenditure from 2001 to 2017	$ millions	131 306	100%
Total acquisitions from 2001 to 2017	$ millions	21 109	16%
Total disposals from 2001 to 2017	$ millions	-20 796	-16%
Total impairments from 2001 to 2017	$ millions	-15 425	-12%

Total impairments of US$15.4 billion were made from the year 2001 to 2017 which represents 12% of the invested capital during this period. Notably, the 12% ratio is the second lowest percentage of the five companies analysed. The largest impairment amounts were made in 2012 with a combined value of US$4.0 billion in respect to Vale's ferronickel operations and Australian coal assets. The ferronickel impairment was primarily due to damage to two furnaces in June 2016 at the Onca Puma nickel operations.

7.10 Return on capital employed

Figure 7.13 shows ROCE, net capital allocated to investment activities as a percentage of operational costs and the basket commodity price index. The purpose of the graph is to test the relationship between the three parameters. The data points contained in Figure 7.13 are provided in Appendix 11.27.

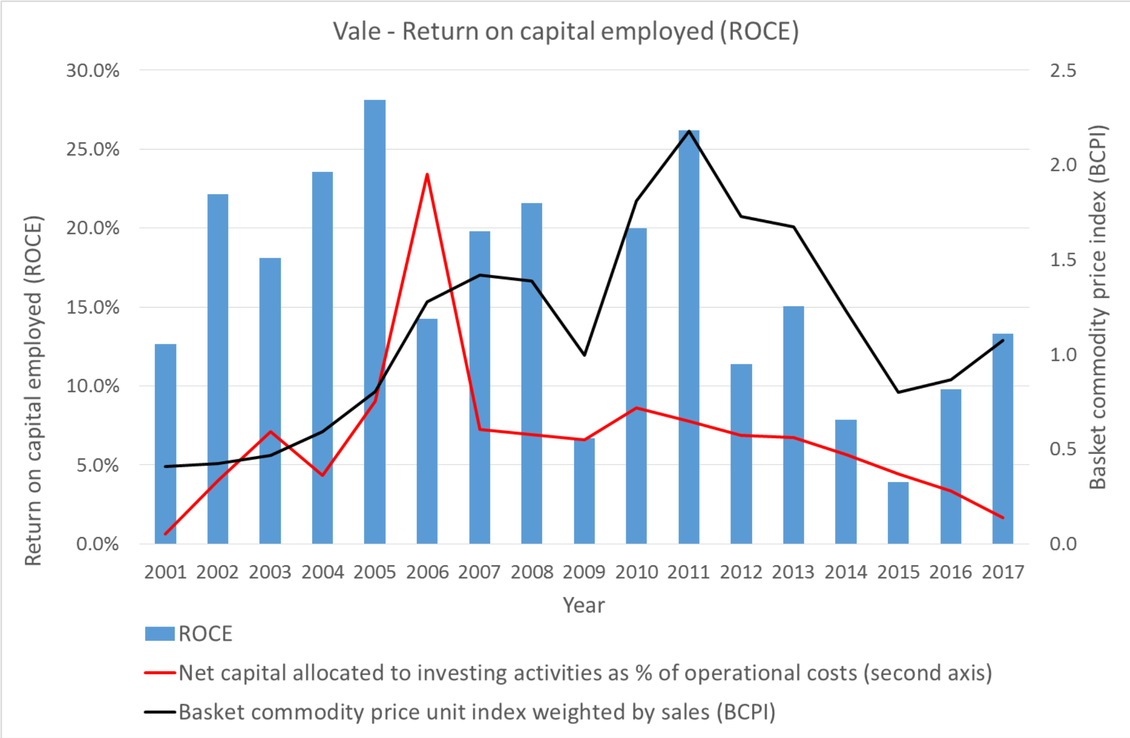

Figure 7.13: Vale ROCE for the period 2001 to 2017

Figure 7.13 indicates a weak positive linear relationship between ROCE and the prevailing prices of commodities produced with a Pearson correlation coefficient of 0.12. This result is unexpected as commodity prices typically have a large impact on revenue and earnings. The low correlation could be due to the high ROCE achieved in a relative low commodity price environment during 2001 to 2005. The average ROCE for Vale over the 17 year period is 16.1%, which compares to average ROCE achieved by Anglo American, BHP, and Rio Tinto of 15.0%, 22.4% and 17.9% respectively. Figure 7.14 indicates a weak positive linear relationship between ROCE and net capital allocated to investments as a percentage of operational costs, with a Pearson correlation coefficient of 0.12. This indicates that the amount of capital employed had no impact on ROCE. Figure 7.14 shows ROIC, net capital allocated to investment activities as a percentage of operational costs and the basket commodity price index.

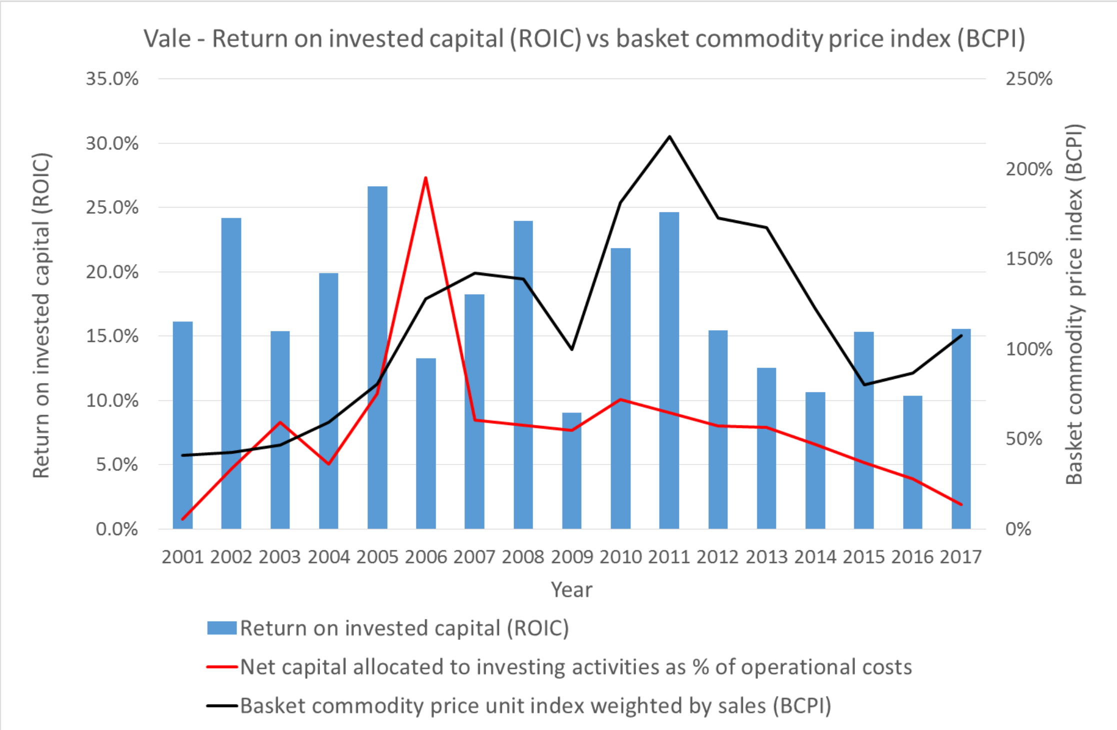

Figure 7.14: Vale ROIC for the period 2001 to 2017

Similar to ROCE, Figure 7.14 indicates a very weak positive linear relationship between ROIC and the prevailing commodity prices, with a Pearson correlation coefficient of 0.09. This can also be attributable to high ROIC's achieved during low commodity prices in the period from 2001 to 2005. The average ROIC for Vale over the 17 year period is 17.2%, which compares to ROIC of 15.0%, 22.2% and 17.9% achieved by Anglo American, BHP and Rio Tinto respectively. Figure 7.14 also a very weak negative linear relationship between ROIC and the net capital allocated to investment activities as a percentage of operational costs, with a Pearson correlation coefficients of -0.04. This indicates there was no correlation between the amounts of capital allocated in a particular year and the return on capital obtained in that year. This is expected as it typically takes a number of years before return on invested capital is realised.

7.11 Hypothesis test

Figure 7.15 indicates ROIC relative to CIPCI. Figure 7.15 aims to test the hypothesis that timing of capital allocation decisions in relation to the prevailing commodity prices has an influence on the returns realised on the capital expenditure.

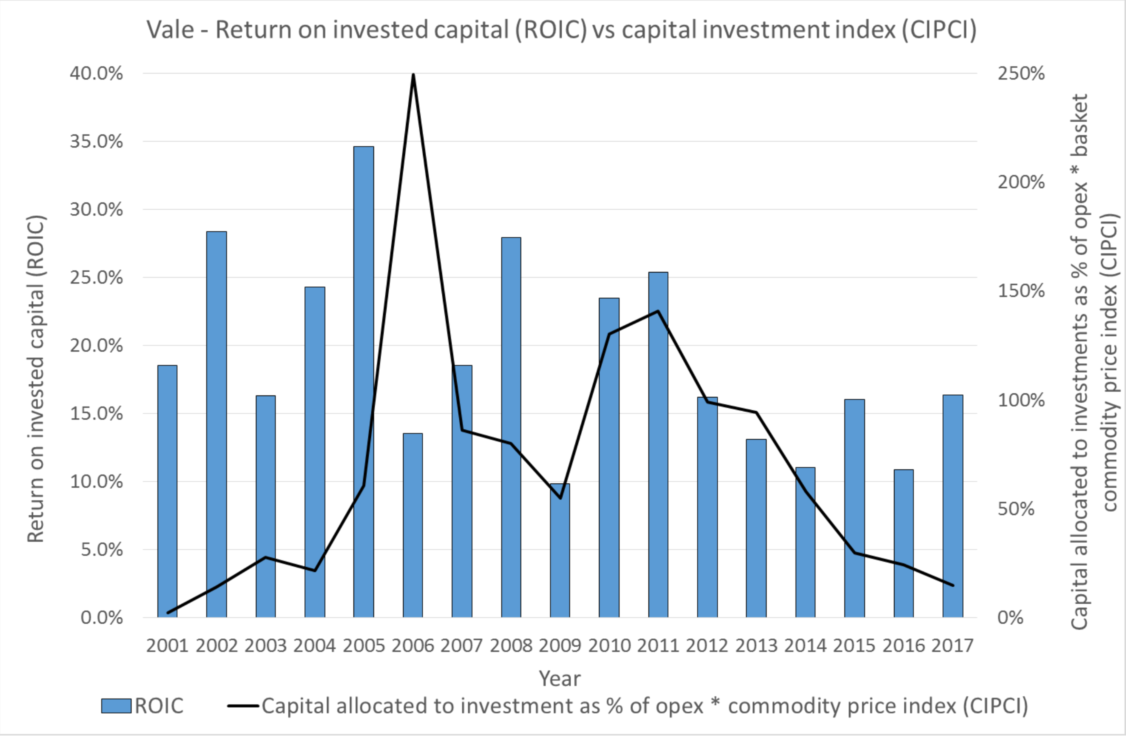

Figure 7.15: Vale ROIC as a function of CIPCI for the period 2001 to 2017

Similar to Anglo American, BHP and Rio Tinto, Figure 7.15 indicates high variability in CIPCI index which indicates that typically Vale did not follow a contrarian investment approach where capital expenditure is increased during periods of low commodity prices. The standard deviation of the CIPCI index is 60% with a mean of 65%. The large standard deviation of 60% relative to a mean of 65% indicates that historical capital allocations amounts varied significantly from year to year. The results are influenced to a large extend by the large Inco acquisition in 2006. In order to test the linear relationship between ROIC and CIPCI a scatter diagram was developed for ROIC and CIPIC as shown in Figure 7.16.

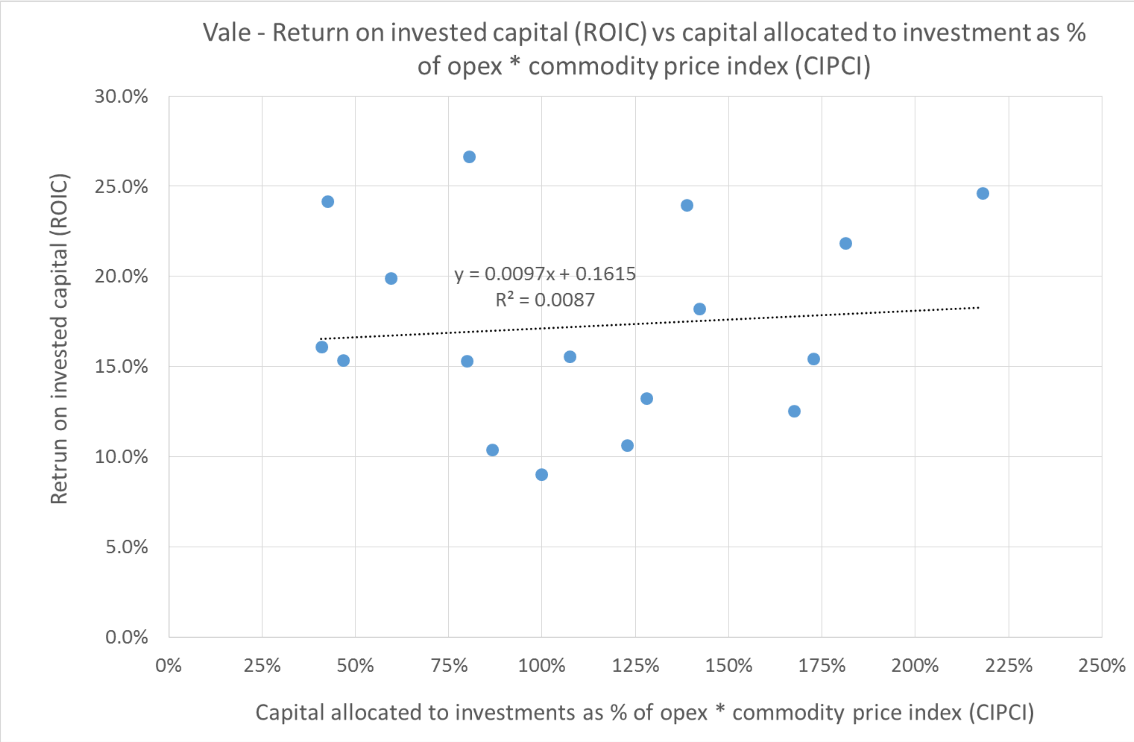

Figure 7.16: Vale – scatter diagram of ROIC and CIPCI for the period 2001 to 2017

Figure 7.16 indicates a very weak positive linear relationship between ROIC and CIPCI, with a coefficient of determination (R^2) of 0.009. This indicates than less than one percent of the variations in ROCE can be explained by variations in CIPIC. The Pearson correlation coefficient between CIPIC and ROIC for Vale is 0.04., indicating a very weak positive linear relationship between the two parameters. Figure 7.17 shows the relationship between ROCE and CIPCI, with a scatter diagram provided in Figure 7.18 to test the linear relationship between the two variables.

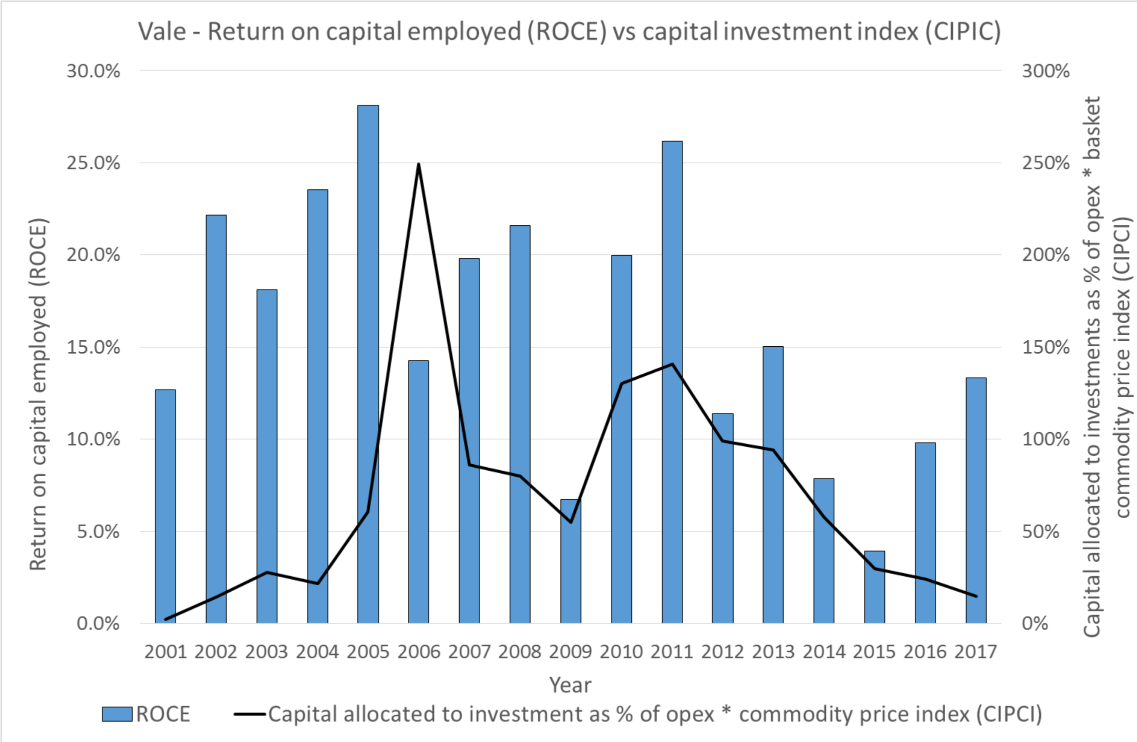

Figure 7.17: Vale ROCE as a function of CIPCI for the period 2001 to 2017

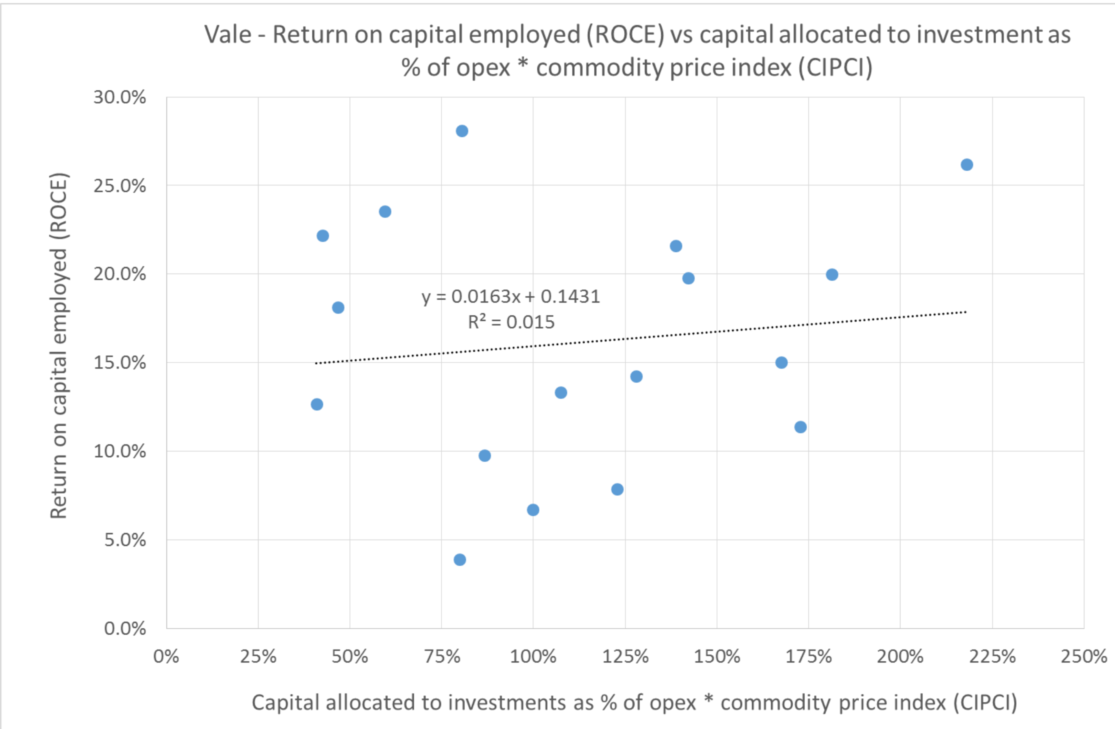

Figure 7.18: Vale – scatter diagram of ROCE and CIPCI for the period 2001 to 2017

Figure 7.17 and Figure 7.18 indicates a similar result for ROCE as for ROIC, with a coefficient of determination (R^2) of 0.015. This indicates that only 1.5% of the variations in ROCE can be explained by variations in CIPCI. Pearson correlation coefficient of 0.11 between ROCE and CIPCI indicates a weak positive linear relationship between the two variables. Figure 7.19 shows the relationship between CIPIC and ROCE achieved three years after the capital investment was made. Similar to the other companies analysed, the delay of three years is explained on the basis that there is a time delay between when capital is committed and when a return on capital is realised. The linear relationship between ROCE achieved three years after the investment and CIPCI is shown in a scatter diagram in Figure 7.20.

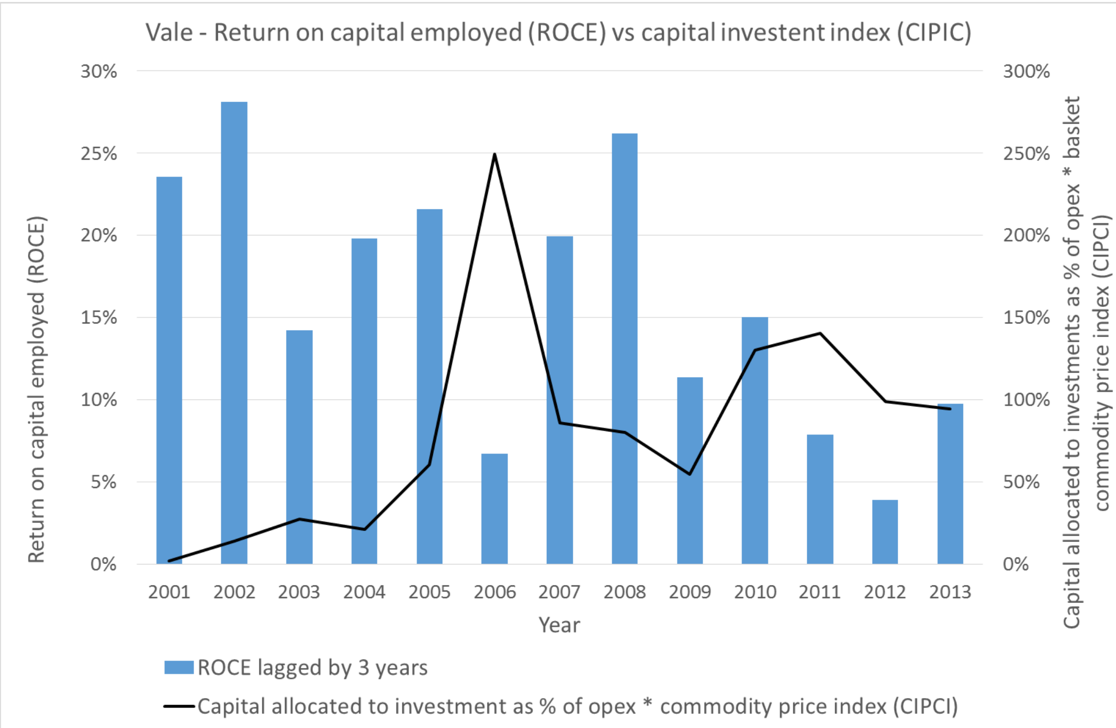

Figure 7.19: Vale ROCE lagged by 3 years as a function of CIPCI, 2001 – 2013

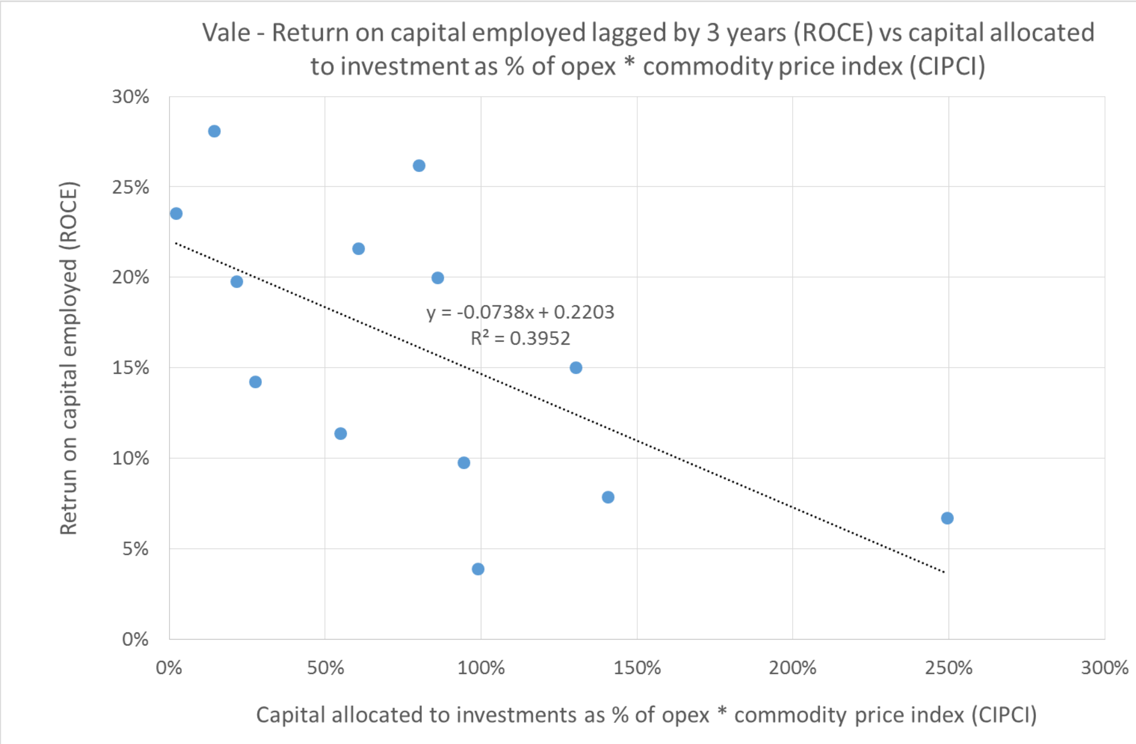

Figure 7.20: Vale – scatter diagram of ROCE lagged by 3 years and CIPCI, 2001 – 2013

Similar to the results obtained with Anglo American, BHP and Rio Tinto, a negative linear relationship was obtained between ROCE three years after the capital investment, and CIPCI. The coefficient of determination (R^2) of 0.4 indicates that 40% of the variations in the ROCE achieved three years after the investment was made can be explained by variations in CIPCI. The Pearson correlation coefficient of -0.62 indicates a strong negative linear relationship. It can be seen that periods with a high CIPCI index typically had a low ROCE three years after the capital investment, and vice versa. This result is indicative that there is a higher probability of achieving higher returns on capital investments if the capital is allocated during periods of lower commodity prices.

7.12 Chapter summary

Vale's revenue was predominantly derived from iron ore sales contributing 72.7% of total revenue in 2017. Over the period from 2001 to 2017 Vale was able to increase real term EBITDA by 844%. This was primarily achieved through production volume growth of 165% over the 17 year period. The high growth rates in the production volume unit index were made possible by a high percentage allocation of capital to investment activities, equal to 49% of the annual operational cost expenditure. This is substantially higher than Anglo American, Vale and Rio Tinto whom typically committed amounts between 23% to 32% of annual operational costs to investment activities.

In 2006 a significant acquisition was made when Vale acquired 87% of Inco's ordinary shares for a total amount of US$17.1 billion. This was equal to three times EBITDA in the preceding year. From 2008 to 2010 there was a steady decrease in capital allocation to growth and stay-in-business as the focus was on decreasing debt incurred in funding the acquisition. Strong commodity prices from 2010 to 2014 contributed to increased capital allocation to growth projects. Similar to Anglo American, BHP and Rio Tinto there is a strong positive linear relationship between the relative strength of the prevailing commodity price and value of capital commitments, with a Pearson correlation coefficient of 0.94.

From 2012 to 2017 significant impairments of US$15.4 billion were announced primarily relating to lower nickel, coal and iron ore prices. The total impairments during the period from 2012 to 2017 represents 12% of the total invested capital during this period. Notably, the 12% ratio is the second lowest percentage of the five companies analysed. Similar to Anglo American, BHP and Rio Tinto in a declining commodity price environment, from 2013 to 2017 the focus shifted to return on capital employed and repayment of debt. Net debt peaked at US$30.3 billion in 2012 and progressively decreased to less than US$10 billion in 2017.

The hypothesis test indicates a moderate negative correlation between CIPCI and the return on investment achieved three years after the investment was made. This is similar to the results obtained for Anglo American, BHP and Rio Tinto. This indicates that Vale typically achieved higher returns on capital employed if the capital was allocated during periods of relatively weak commodity prices. The results from the historical capital allocation analysis for First Quantum are provided and discussed in the next chapter.

8 ANALYSIS OF CAPITAL ALLOCATION BY FIRST QUANTUM

8.1 Chapter overview

In this chapter the results from the research study on First Quantum are presented and analysed. The analysis of First Quantum followed the same process as the analysis conducted on Anglo American, BHP, Rio Tinto and Vale provided in Chapter 4, 5, 6 and 7 respectively.

8.2 Historical capital allocation

First Quantum's historical allocation of capital to either building of new assets, purchase of new assets or returning capital to shareholders are provided in Figure 8.1. The terms build, buy and return are as defined in sub-section 3.2.1. The data points contained in Figure 8.1 are provided in Appendix 11.33 and Appendix 11.34.

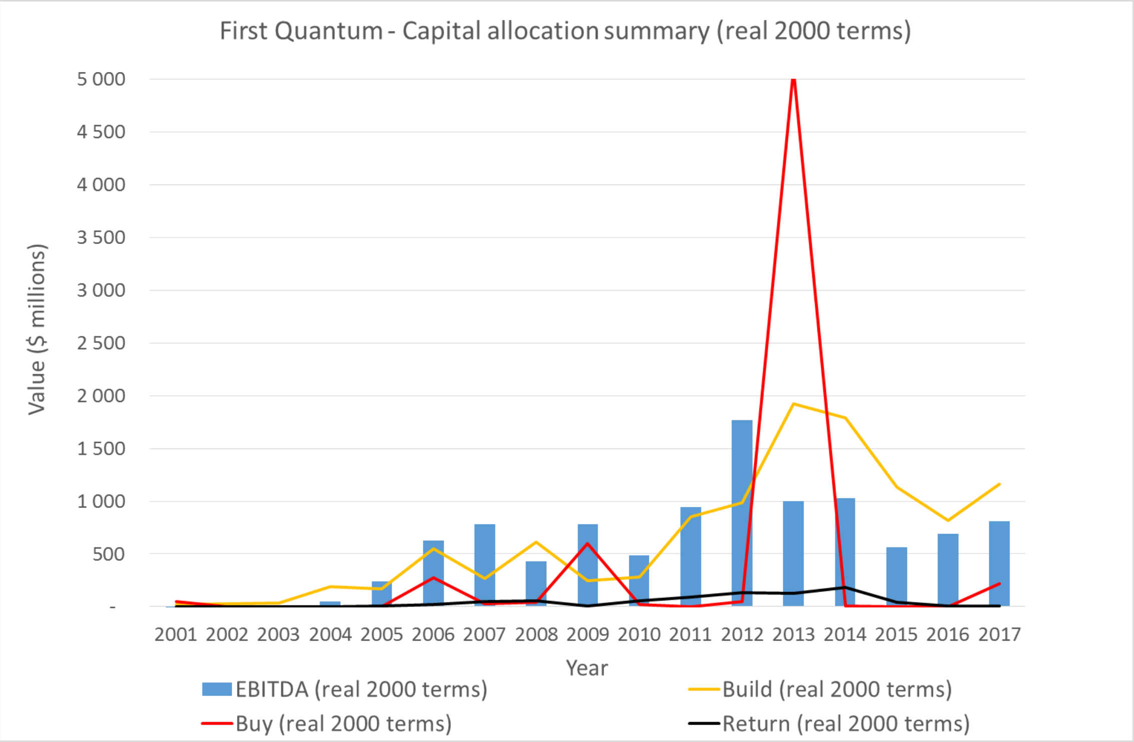

Figure 8.1: First Quantum summary of historical capital allocation for the period 2001 to 2017

Figure 8.1 indicates that First Quantum is a growth company with a very high allocation of capital to growth, and with very low capital return to shareholders. In 2013 First Quantum made a significant capital investment with the acquisition of Inmet Mining Corporation for US$5.1 billion. The major capital allocation decisions made by First Quantum over the analysis period are summarised below (First Quantum, 2001 – 2017):

- Figure 8.1 indicates a significant increase in the build graph from 2001 to 2013. This increase is due to the approval of a number of expansion projects as summarised below:
    - Kansanshi copper-gold project was approved in the year 2002 for a total capital cost of US$163 million;
    - Project approval of US$226 million was granted in 2006 for the construction and development of the Frontier copper mine in the DRC;
    - In November 2007, approval was given for the development of the Kolwezi tailings project for a total capital cost of US$553 million;
    - Development of the Kevitsa nickel/copper mine in Finland was approved on 30 November 2009 with a total capital cost of US$480 million;
    - During 2010 an investment of US$350 million was approved for the expansion of Kansanshi copper mine to increase annual copper production from 250,000 tonne to 400,000 tonnes;
    - During 2011 an investment of US$690 million was approved for the construction of a new 300,000 tonnes copper per annum copper smelter at Kansanshi mine;
    - In 2013 approval was given for the development of the Sentinel copper project in Zambia for a total capital cost of US$1.72 billion; and

- In 2013 the Cobre Panama copper project located in Panama was approved for construction with a total estimated capital cost of US$6.3 billion.

- During 2001 First Quantum acquired Phelps Dodge's 80% interest in the Kansanshi copper gold deposit located in Zambia, for a total amount of US$50 million;
- The increase in the buy graph in 2006 was due to the acquisition of Adastra Minerals Inc. for a total cost of US$273 million;
- In 2009 First Quantum made two large acquisitions namely Kiwara PLC for a total amount of US$260 million and Ravensthorpe nickel operation for a total amount of US$340 million;
- The significant increase in the buy graph in 2013 is due to the US$5.1 billion acquisition of Inmet Mining Corporation; and
- During 2016 the Kevitsa nickel/copper operation was sold to Boliden for a total amount of US$728 million. A net loss on disposal of US$237 million was realised on this sale.

Analysis of the major capital allocation decisions made by First Quantum over the analysis period indicates a consistent allocation of capital to growth projects throughout the commodity price cycle. The most important investment was the development of the Kansanshi copper mine in Zambia, and the acquisition of Inmet Mining Corporation. Kansanshi was a key project development which generated a substantial amount of free cash flow over the analysis period. The free cash flow from Kansanshi allowed First Quantum to invest in mining operations in other geographical areas such as Australia, South America, Central America and Europe. A more detailed summary of the historical capital allocation split between stay-in-business capital expenditure, expansion capital expenditure, acquisitions and disposals and total capital returns to shareholders over the analysis period is provided in Figure 8.2.

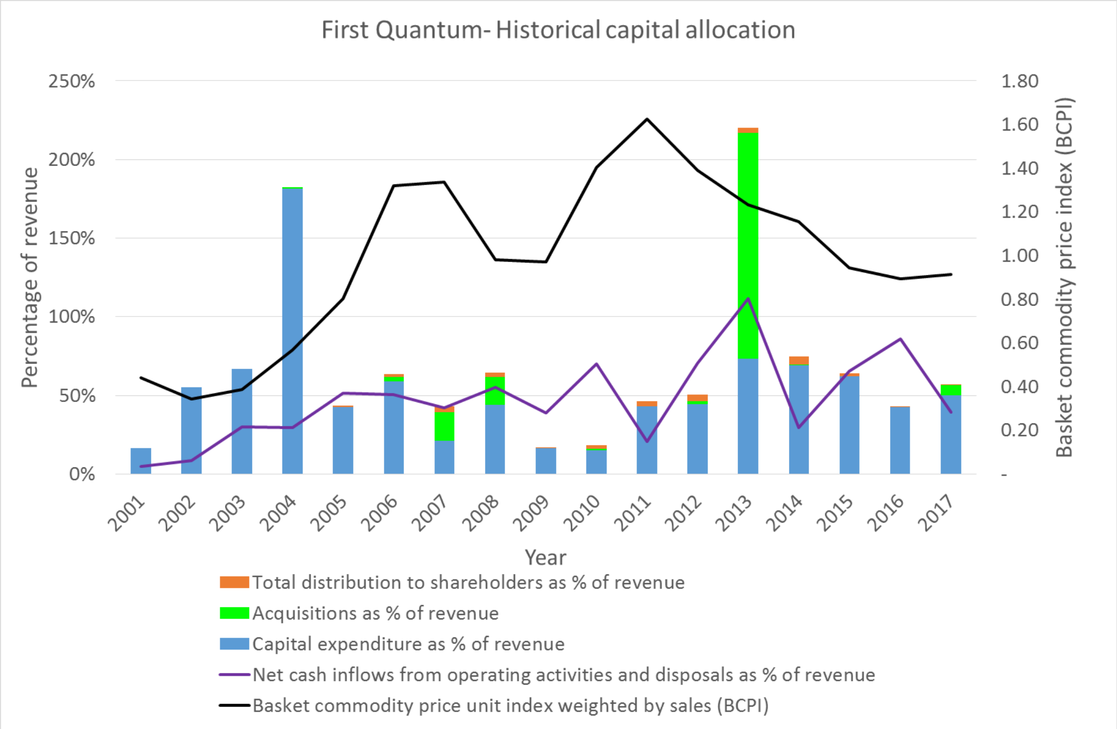

Figure 8.2: First Quantum summary of historical capital allocation for the period 2001 to 2017

In 2002, 2003, 2004 and 2013 capital allocated to investments far exceeded capital inflows from operations and disposals. The primary investments during these periods were the development of Kansanshi Copper Mine and the acquisition of Inmet Mining Corporation. Capital allocated to investments exceeded capital inflows again in 2006 to 2008, with the project development of Frontier Mine, and a US$283 million investment in Equinox in 2007. The disposal of Frontier Mine and Kolwezi Tailings project to ENRC in 2013 for a total amount of US$1.25 billion increased cash inflows in 2013, which enabled First Quantum to finance the US$5.1 billion acquisition of Inmet Mining Corporation in 2013. During 2014 to 2017 capital outflows remained high with the development of the US$6.3billion Cobre Panama project. Figure 8.2 indicates that First Quantum maintained high capital allocations to investment activities throughout the commodity oddity cycles.

8.3 Overview of historical financial performance

First Quantum is a mid-sized mining company that derives most of its revenue from copper production. Over the analysis period First Quantum experienced exceptional growth, with shareholders equity increasing by 14,290% over the 17 year period. An overview of the financial performance of First Quantum from 2001 to 2017 is provided in Figure 8.3 in which total revenue, total capital expenditure, total operational costs and EBITDA are provided in real 2000 terms.

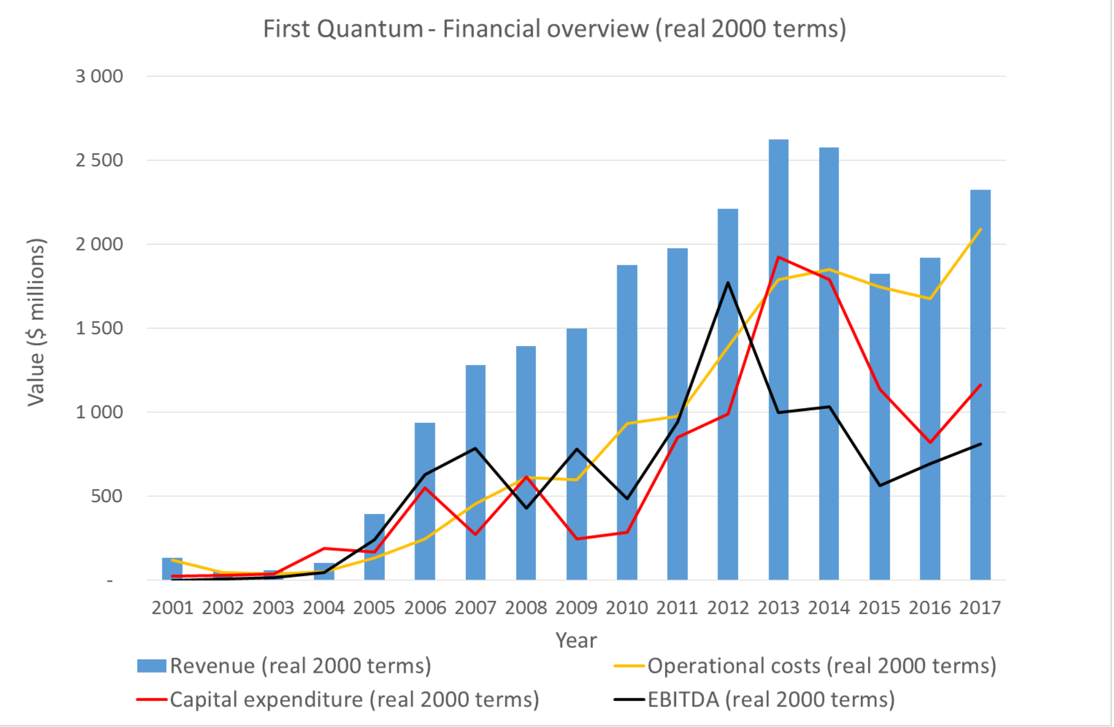

Figure 8.3: Financial overview of First Quantum for the period 2001 to 2017

Figure 8.3 indicates very strong growth in revenue between 2001 and 2013 with a CAGR of 28.1%. From 2014 to 2015 revenue dropped by 29% due to drop in commodity prices, specifically copper being the major commodity produced by First Quantum. First Quantum managed to increase EBITDA from -US$2 million in 2001 to US$811 million in 2017 in real 2000 money terms. Total capital expenditure progressively increased in line with year-on-year increases in revenue during 2001 to 2012, and subsequently decreased from 2012 to 2017.

Operational costs increased over the analysis period in-line with increases in production volumes.

8.4 Revenue and production volume growth

First Quantum's revenue in real 2000 terms derived from commodities produced for the period 2001 to 2017 is shown in Figure 8.4. Most of First Quantum's revenue was obtained from the sale of copper. The data points contained in Figure 8.4 are provided in Appendix 11.36 to Appendix 11.38.

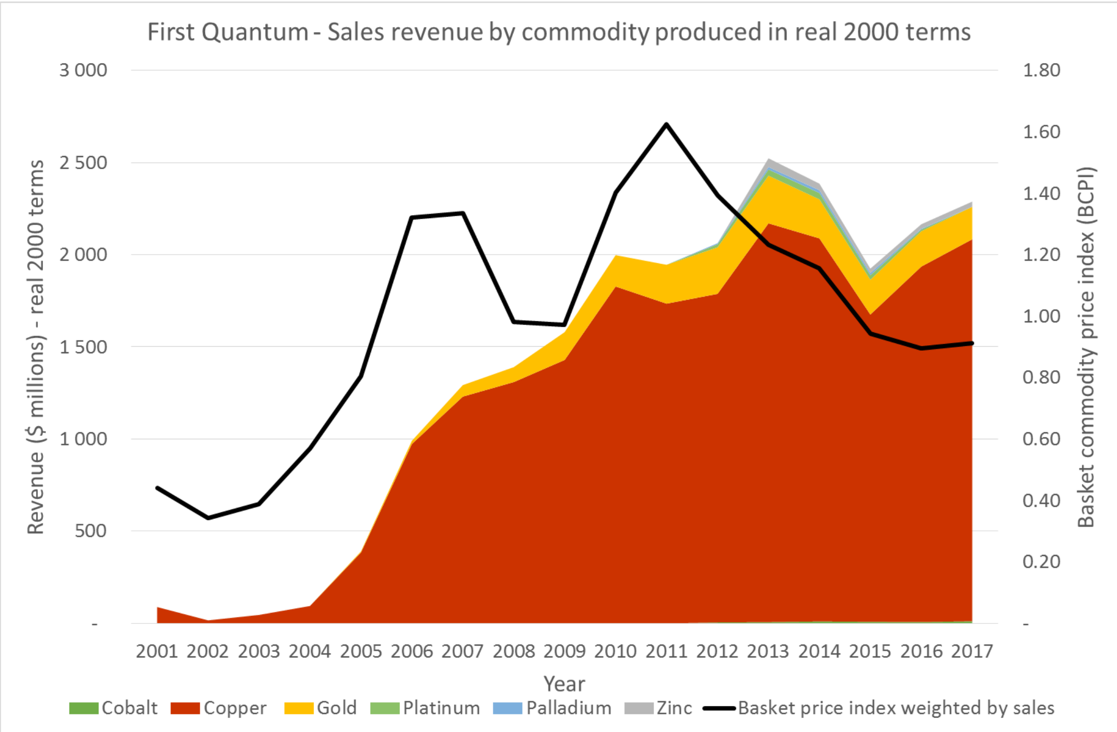

Figure 8.4: First Quantum revenue from commodities production in real 2000 money terms for the period 2001 to 2017

Figure 8.4 indicates a strong positive linear relationship between total revenue and the weighted average basket price index with a Pearson correlation coefficient of 0.73. Notably, the correlation between commodity prices and revenue is not as strong as for the other companies evaluated, which is due the significant increase in production volumes over the period. Table 8.1 provides the percentage revenue split between commodities produced by First Quantum in the periods 2001, 2008, 2011 and 2017.

Table 8.1: First Quantum revenue split by commodity produced

Revenue split by commodity produced	Unit	2001	2008	2011	2017
Cobalt	%	0.0%	0.0%	0.0%	0.5%
Copper	%	100.0%	94.2%	84.9%	85.7%
Gold	%	0.0%	5.8%	10.3%	7.3%
Nickel	%	0.0%	0.0%	4.8%	5.3%
Platinum	%	0.0%	0.0%	0.0%	0.0%
Palladium	%	0.0%	0.0%	0.0%	0.0%
Zinc	%	0.0%	0.0%	0.0%	1.2%
Total	**%**	**100%**	**100%**	**100%**	**100%**
Number of commodities produced		**1**	**2**	**3**	**5**

Table 8.1 indicates that First Quantum was only partially successful in diversifying its range of commodities produced over the analysis period. Over the analysis period the number of commodities produced increased from one to five, however in 2017 the largest portion of revenue was still derived from copper sales. Figure 8.5 shows the growth in production volumes relative to the production volumes achieved in the year 2001. Figure 8.5 also shows the net capital allocated to investing activities as percentage of operational costs.

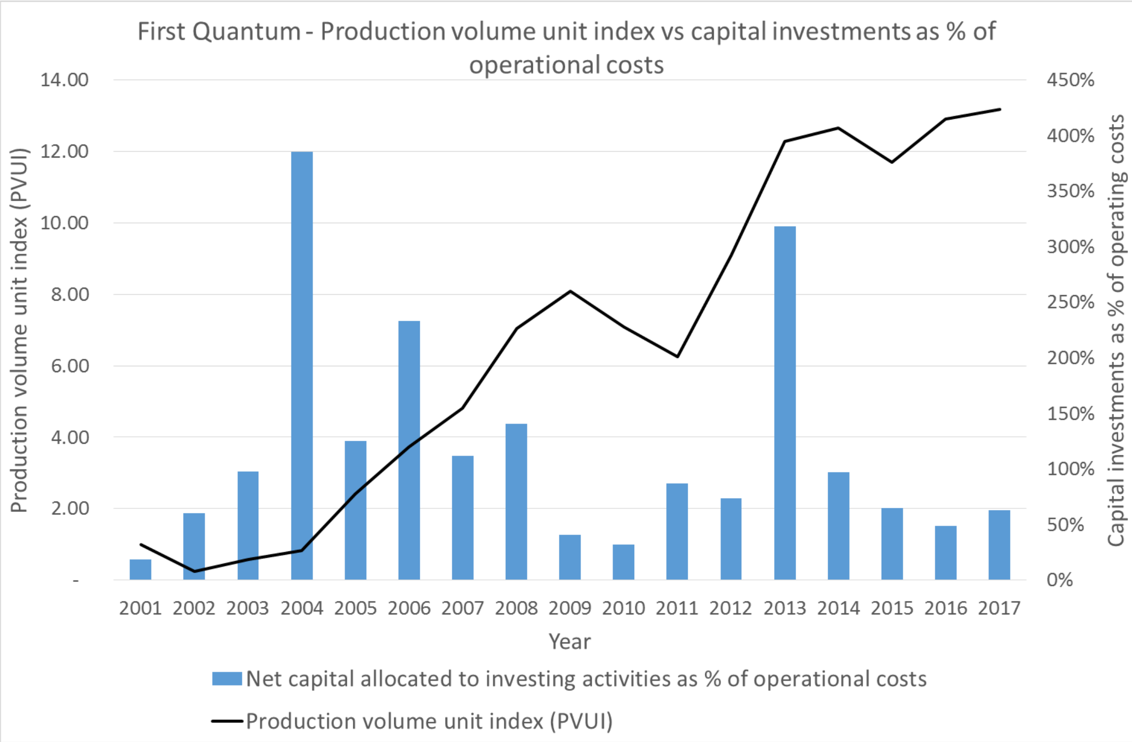

Figure 8.5: First Quantum production volume growth index for the period 2001 to 2017

Over the 17 year analysis period production volumes progressively increased by 1,220% which is a CAGR of 17.5%. On average First Quantum committed capital towards growth activities equal to 108% of the annual operational costs expenditure. This far exceeds the range of averages of 23% to 49% of annual operational costs that the other companies allocated growth initiatives. The significantly higher allocation of capital to growth projects is one of the primary reasons why First Quantum's increase in production volumes far exceeded the increases achieved by the other mining companies. The major investment was in 2004 when First Quantum committed US$205 million for the construction of the Kansanshi project located in Zambia (First Quantum, 2004). The rapid growth in production volumes between 2005 and 2009 is primarily due to production ramp-up at Kansanshi Copper Mine. The acquisition of Inmet Mining Corporation in 2013 added a number of copper and nickel mines to First Quantum's portfolio which are primarily responsible for the increase in production volume growth index from 2012 to 2013.

8.5 Capital commitments and actual capital expenditure

Capital commitments towards SIB capital and expansionary capital in real 2000 terms, are indicated in Figure 8.6 relative to the basket commodity price index. Capital commitment is an early indicator of capital allocation, as there is typically a time delay between when a capital commitment is made and when the capital is expensed.

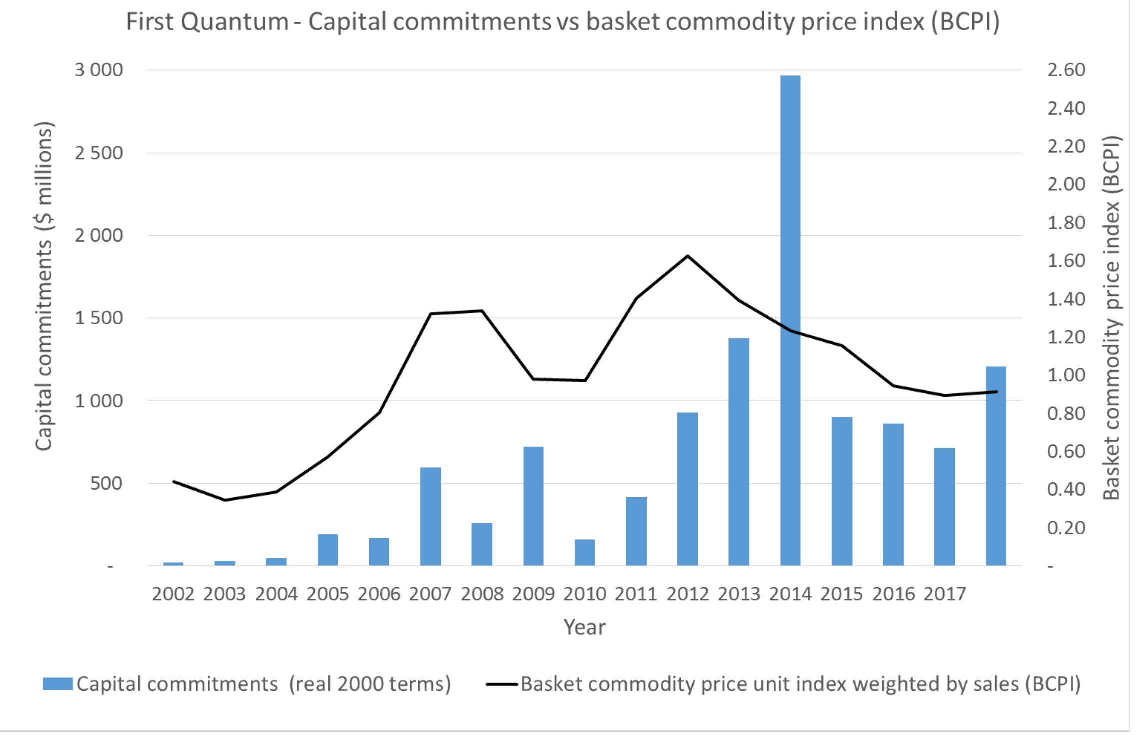

Figure 8.6: First Quantum capital commitments relative to prevailing commodity prices for the period 2001 to 2017

Figure 8.6 indicates a moderate positive linear relationship between capital commitments and the basket commodity price index. In Figure 8.7 the linear relationship between the capital commitments and the prevailing commodity prices is represented in a scatter diagram.

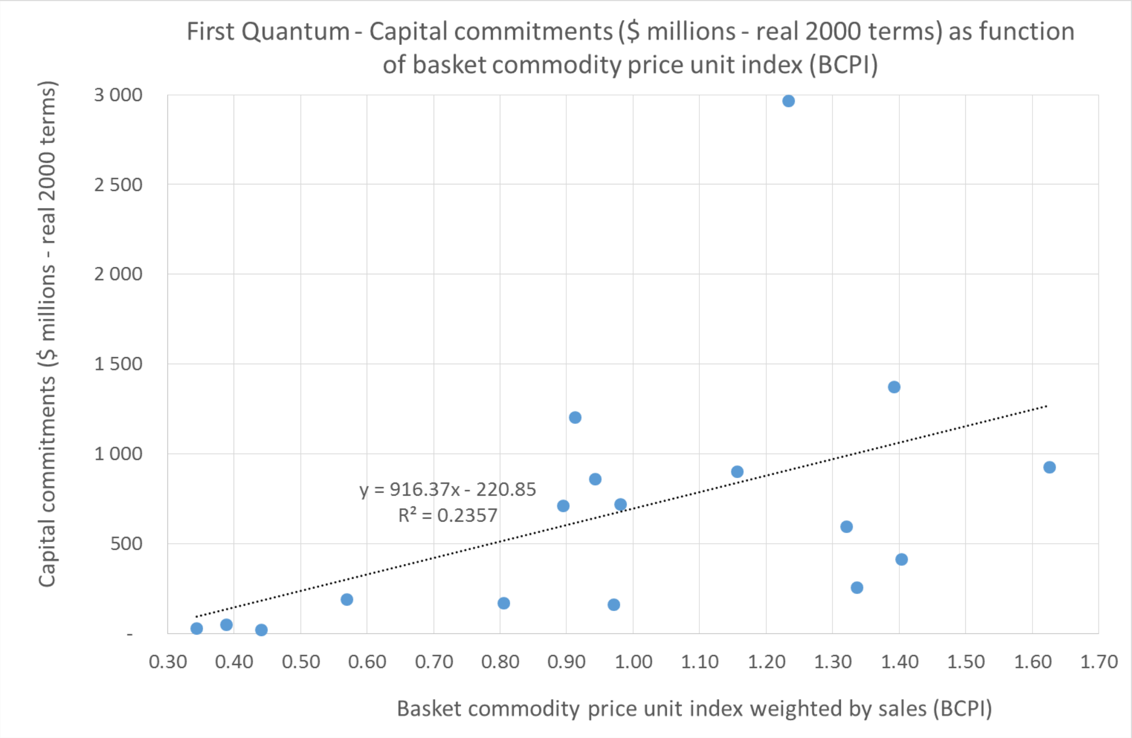

Figure 8.7: First Quantum - scatter diagram of capital commitments relative to prevailing commodity prices for the period 2001 to 2017

Figure 8.7 indicates a moderate positive linear relationship between capital commitments and the prevailing basket commodity prices. The coefficient of determination (R^2) is 0.24, which means that 24% of the variations in the amount of capital allocated can be explained by variations in the prevailing basket commodity prices index. The Pearson correlation coefficient is 0.49, which is the lowest correlation between capital commitments and prevailing commodity prices amongst all companies analysed. The low correlation indicates that First Quantum typically allocated capital towards growth initiatives throughout the commodity price cycle, as opposed to the other companies where more capital were allocated during periods of high commodity prices. The results were skewed to a certain extend by the high growth rates achieved by First Quantum in both production volumes and revenue over the period. Due to this a more meaningful comparison can be obtained by using capital allocation as a percentage of operational costs as indicated in Figure 8.8.

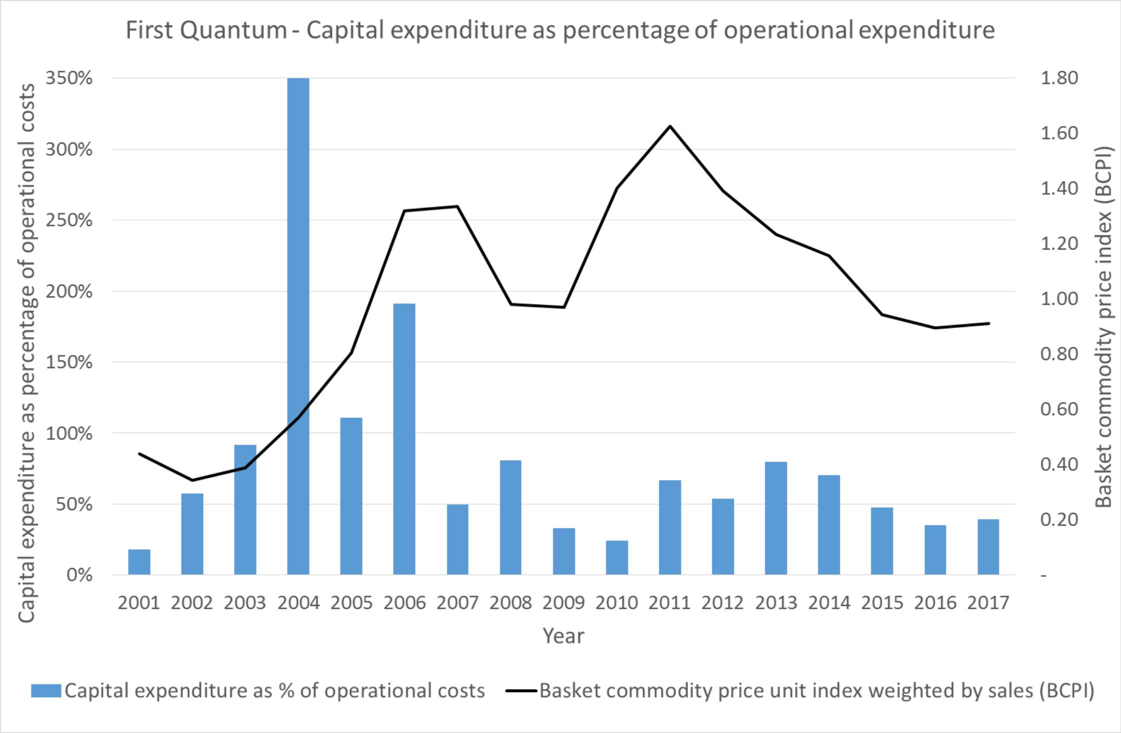

Figure 8.8: First Quantum capital commitments as percentage of operational costs relative to prevailing commodity prices for the period 2001 to 2017

Figure 8.8 indicates that a very weak negative linear relationship between capital allocations as a percentage of operational costs and the prevailing commodity price, with a Pearson correlation coefficient of -0.09. This indicates that First Quantum consistently allocated capital towards investments throughout the commodity price cycles. Figure 8.9 indicates actual capital expenditure as a percentage of operational costs relative to the basket commodity price index.

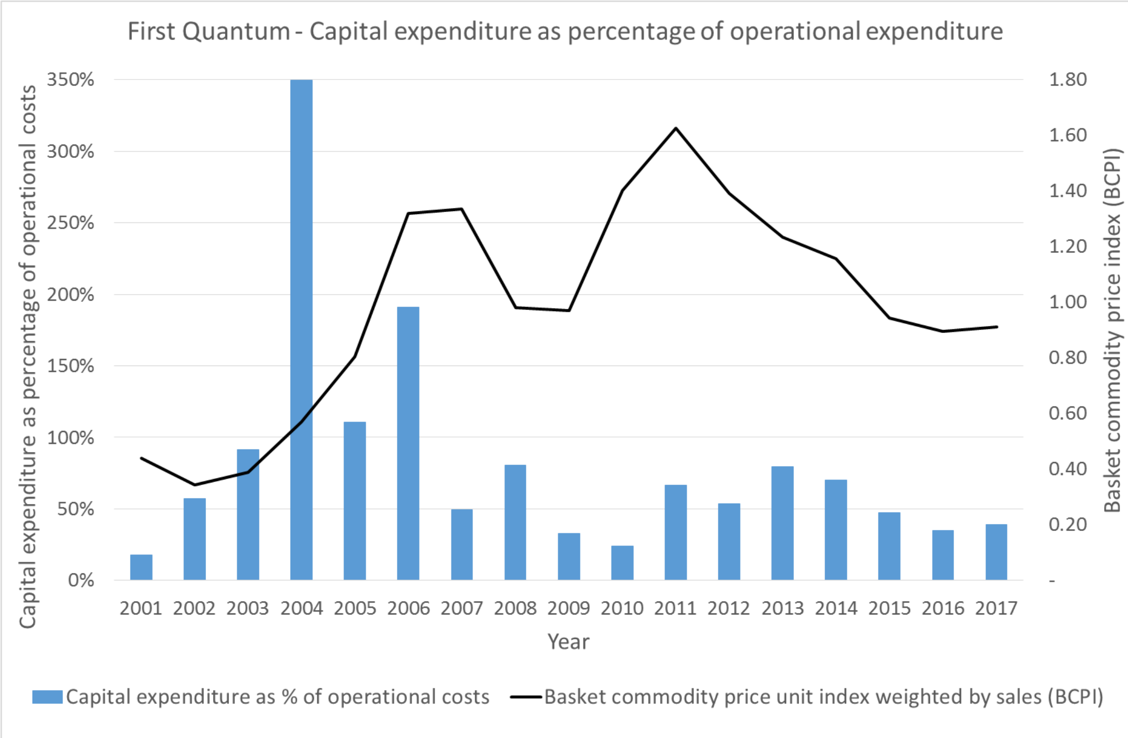

Figure 8.9: First Quantum capital expenditure as percentage of operational costs for the period 2001 to 2017

As shown in Figure 8.9 capital expenditures were greater than operational costs in 2004, 2005 and 2006. This was primarily due to the significant investment in the Kansanshi copper project and growth from a low operational base. As operations within First Quantum matured the capital expenditure settled within a range of 24% to 80% of operational costs. The average capital expenditure as a percentage of operational costs over the 17 year period is 82%. This compares to a range of 21% to 49% for the other companies in the analysis. The Pearson correlation coefficient between capital expenditure as a percentage of operational costs and the basket commodity price index is -0.17, indicating a weak negative linear relationship between capital expenditure and the prevailing commodity price. This indicates that First Quantum consistently allocated capital throughout the commodity price cycle.

8.6 Distributions to shareholders

Total distributions to shareholders over the analysis period are shown in Figure 8.10. Figure 8.10 indicates that First Quantum over the analysis period was mostly a growth company with very low distributions to shareholders.

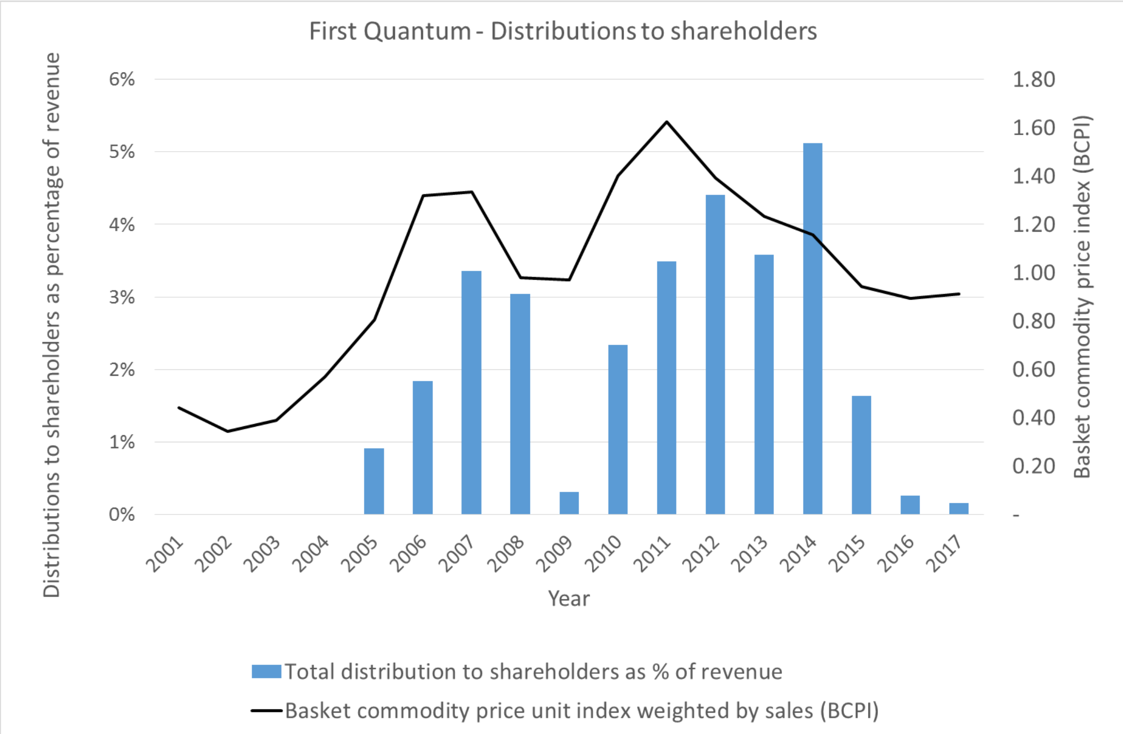

Figure 8.10: First Quantum distributions to shareholders for the period 2001 to 2017

There is a strong positive correlation between distributions to shareholders as a percentage of revenue and the basket commodity price index as shown in Figure 8.10. The Pearson correlation coefficient between the two parameters in 0.77 which indicates a strong positive linear relationship. This indicates that First Quantum typically allocated more capital to distributions to shareholders if earnings were high due to high commodity prices. In comparison with the other mining companies, the value of capital allocated to distributions to shareholders, was relatively low with a maximum dividend of 5.1% of revenue paid to shareholders in 2014. This compares to the other mining companies allocating between 5% to 15% of revenue to dividends and share buy-backs. During 2016 and 2017 no dividends were declared as the company focused on repayment of debt and funding of the large Cobre Panama project. The low distribution of capital to shareholders is typical of a growth company where free cash flow was either allocated to investments of repayment of debt.

8.7 Balance sheet strength

Figure 8.11 shows First Quantum's net gearing ratio and coverage ratio over the analysis period.

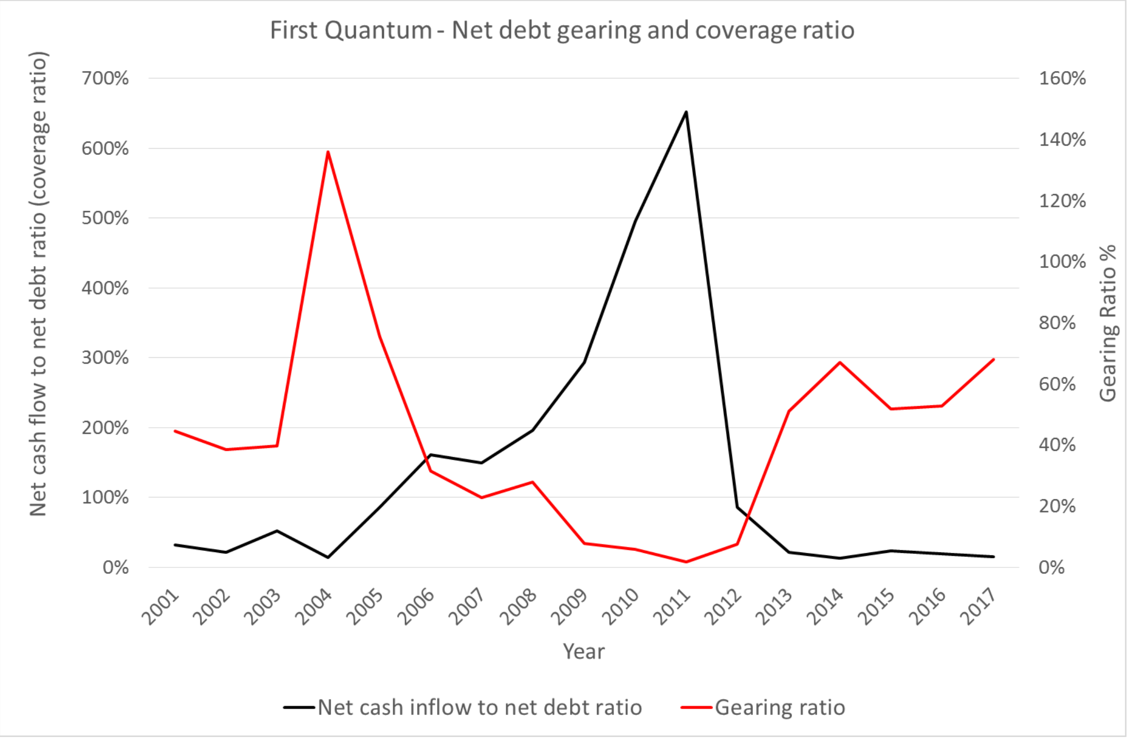

Figure 8.11: First Quantum net cash flows to net debt ratios for the period 2001 to 2017

First Quantum made significant use debt facilities to fund its high allocation of capital towards growth projects, equal to an average of 108% of operational costs. The net gearing ratio peaked at 136% in 2004, after which it gradually reduced to 2% in 2011 due strong operational performances from Kansanshi and commodity price increases. The reduction in gearing ratio enabled First Quantum to complete the US$5.1 billion acquisition of Inmet Mining Corporation in March

2013. The Inmet Mining Corporation acquisition was concluded through a combination of cash and equity, with an approximate US$964 million cash payment. Gearing levels increased in 2016 and 2017 to 68% with the development of the US$6.3 billion Cobre Panama project in Panama.

8.8 Use of debt to finance capital commitments

The split between investments and repayment of debt is provided in Figure 8.12.

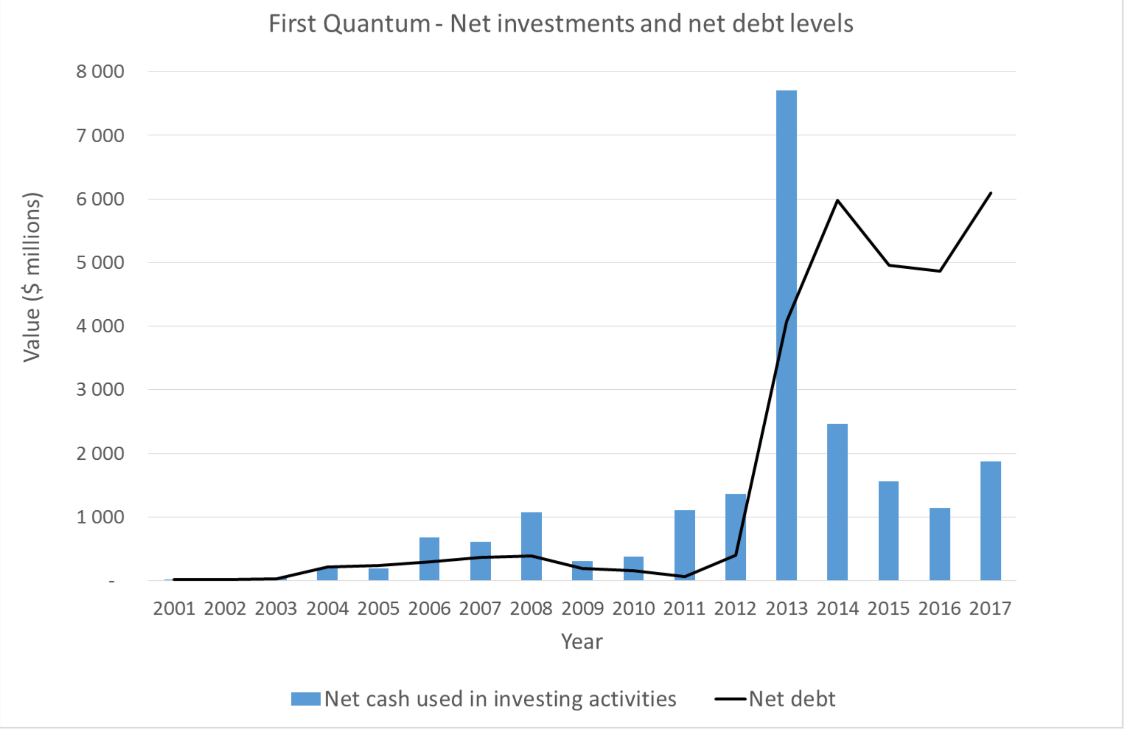

Figure 8.12: First Quantum split between net debt and net investments for the period 2001 to 2017

The substantial increase in net debt is evident in 2013 with the US$5.1 billion acquisition of Inmet Mining Corporation. Net debt increased further in 2014 with the capital expenditure on the Cobre Panama project. Figure 8.12 indicates that since 2013 First Quantum made substantial use of debt to finance its growth investments.

8.9 Impairments

Figure 8.13 shows First Quantum's historical impairments relative to the basket commodity price unit index, and the net cash flow from acquisitions and disposals.

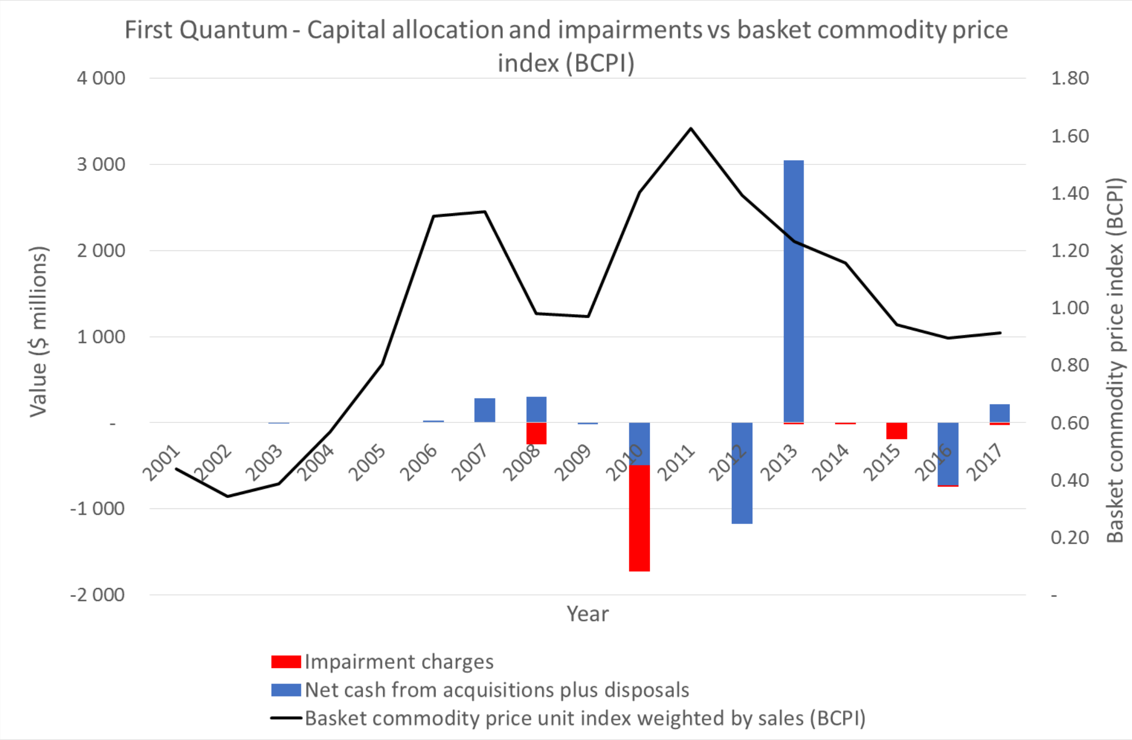

Figure 8.13: First Quantum historical capital allocation and impairments 2001 – 2017

Figure 8.13 indicates a significant impairment in 2010 of US$1.2 billion in relation to the legal ownership of the Kolwezi project and Frontier mine in the Democratic Republic of the Congo. The Inmet acquisition in 2013 substantially increased the net cash outflow as shown in Figure 8.13. Figure 8.13 indicates no correlation between the net value of acquisitions and disposals and the basket commodity price index. Table 8.2 provides a breakdown of the total capital allocation and total impairments from 2001 to 2017.

Table 8.2: Total net investments by First Quantum during 2001 to 2017

Description	Unit	Value	% of total net investment
Total net investment from 2001 to 2017	**$ millions**	**16 194**	**100%**
Total capital expenditure from 2001 to 2017	$ millions	14 729	91%
Total acquisitions from 2001 to 2017	$ millions	6 007	37%
Total disposals from 2001 to 2017	$ millions	-4 543	-28%
Total impairments from 2001 to 2017	$ millions	-1 758	-11%

Table 8.2 indicates that First Quantum allocated significantly more capital to expansionary and stay-in-business capital when compared to capital spent on acquisitions. Total impairments of US$1.76 billion was made from 2001 to 2017 which represents 11% of the invested capital during this period. Notably, the 11% ratio is the lowest percentage of the five companies analysed.

8.10 Return on capital employed

First Quantum's ROCE relative to net capital investments as a percentage of operational costs and the basket commodity price index are shown in Figure 8.14. The data points contained in Figure 8.14 are provided in Appendix 11.35.

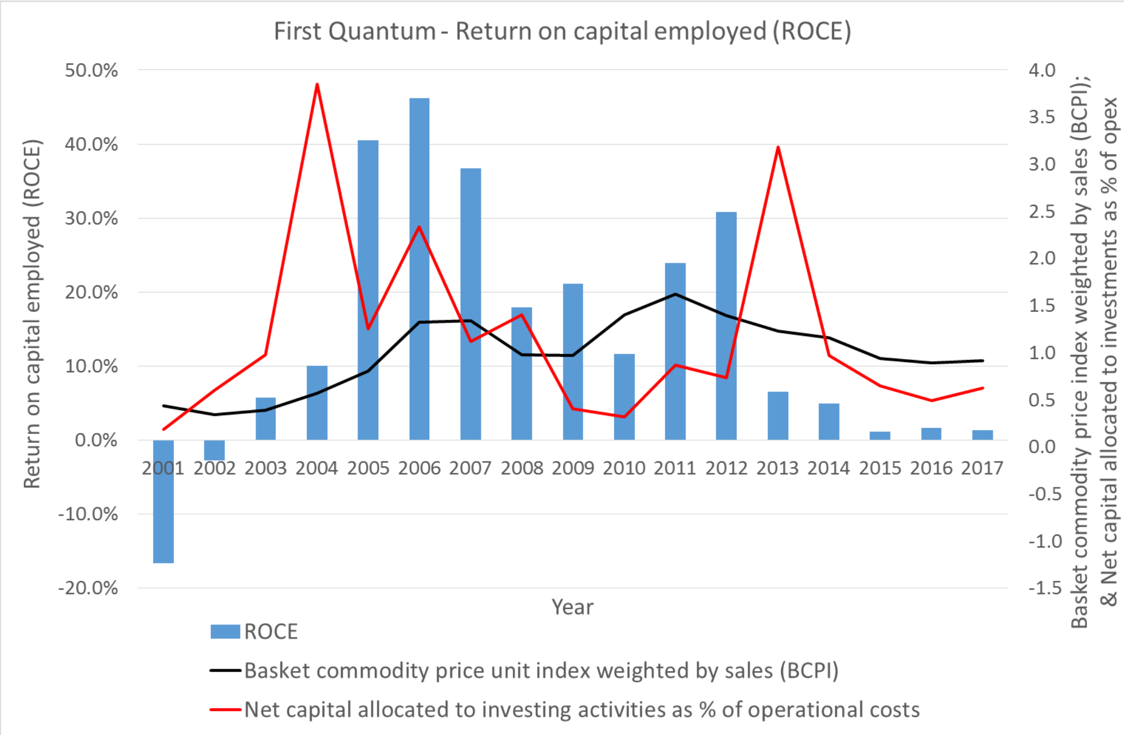

Figure 8.14: First Quantum ROCE for the period 2001 to 2017

There is a strong positive linear relationship between ROCE and the prevailing prices of commodities produced with a Pearson correlation coefficient of 0.57. The positive correlation is expected due to the influence of commodity prices on revenue and earnings. The average ROCE over the 17 year period is 14.2%, which is the lowest amongst the five mining companies. This could potentially be due to the quality of the existing large long life operational assets already in operation in Anglo American, BHP, Rio Tinto and Vale. The Pearson correlation coefficient between ROCE and the net capital allocated to investments as a percentage of operating costs, is 0.24 indicating a weak positive linear relationship. This low correlation indicates that the value of capital investments had very little influence on ROCE. Figure 8.15 shows ROIC relative to net capital investments as a percentage of operational costs and the basket commodity price index.

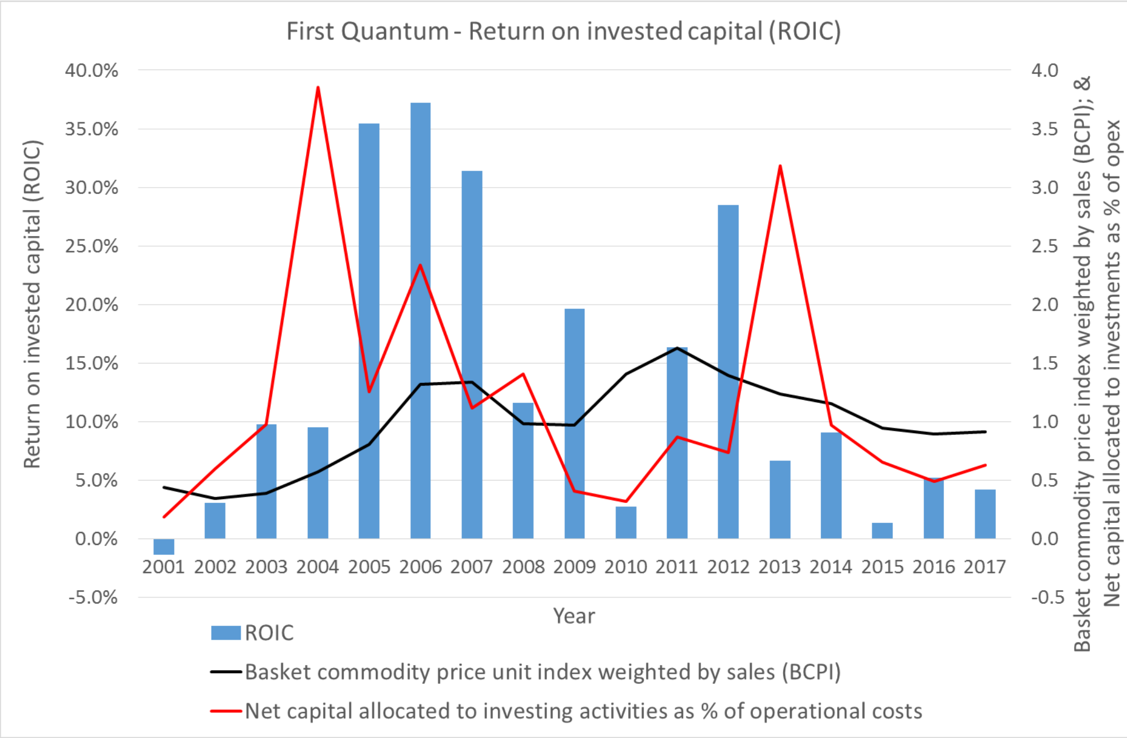

Figure 8.15: First Quantum ROIC for the period 2001 to 2017

Figure 8.15 indicates similar results for ROIC as obtained for ROCE, with a moderate positive linear relationship with the prevailing commodity price. The Pearson correlation coefficient between ROIC and the basket commodity price index over the 17 year analysis period is 0.42. Figure 8.15 shows there a weak positive linear relationship between ROIC and the net amount of capital allocated to investing activities, with a Pearson correlation coefficient of 0.24.

8.11 Hypothesis test

Figure 8.16 shows ROIC relative to CIPCI. In this analysis the hypothesis was tested that the timing of capital allocation decisions in relation to the prevailing commodity prices has an influence on the returns realised on the capital expenditure.

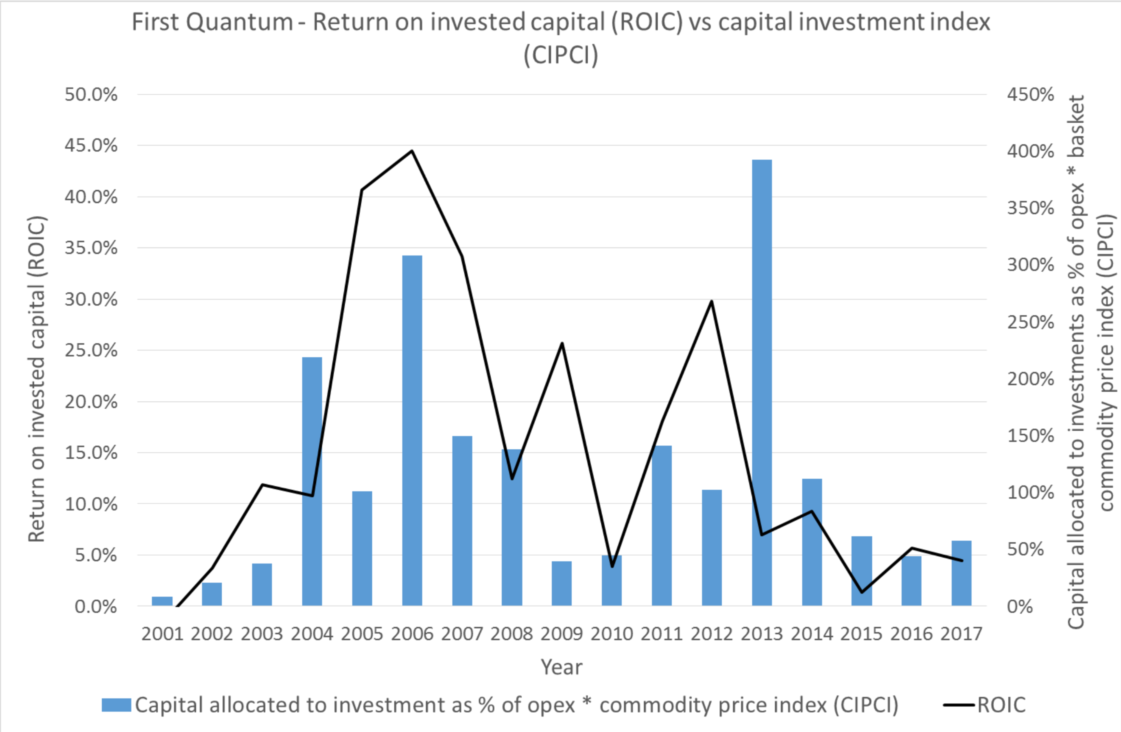

Figure 8.16: First Quantum ROIC as a function of CIPCI for the period 2001 to 2017

Figure 8.16 indicates that First Quantum had a more consistent CIPCI index ranging between 50% and 150% for most part of the analysis period. This indicates that First Quantum more consistently allocated capital to growth activities through the commodity price cycle. In order to test the linear relationship between ROIC and CIPCI a scatter diagram was developed for ROIC and CIPIC as shown in Figure 8.17.

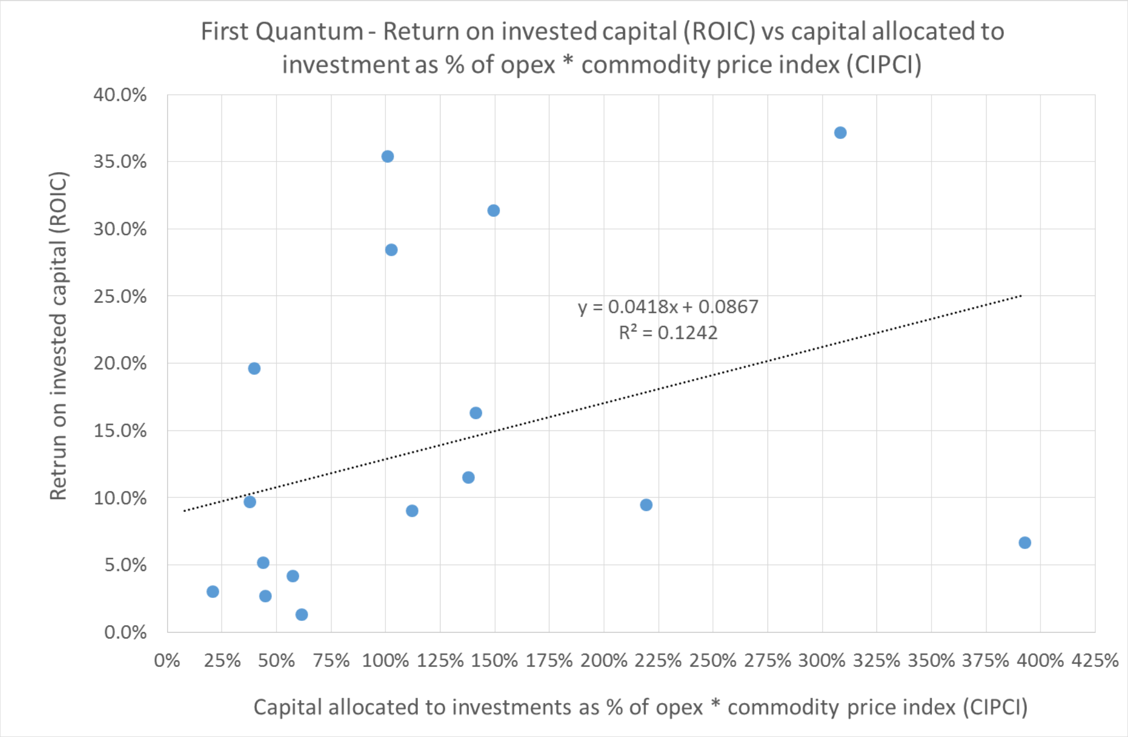

Figure 8.17: First Quantum – scatter diagram of ROIC and CIPCI for the period 2001 to 2017

Similar to the results obtained for Anglo American, BHP, Rio Tinto and Vale, Figure 8.17 indicates a moderate positive linear relationship for First Quantum between ROIC and CIPCI, with a Pearson correlation coefficient of 0.35. The coefficient of determination (R^2) is 0.12 which indicates that 12% of the variation in ROIC can be explained by variations in CIPCI. Figure 8.18 indicates the relationship between ROCE and CIPCI. The linear relationship between ROCE and CIPCI is shown in a scatter diagram in Figure 8.19.

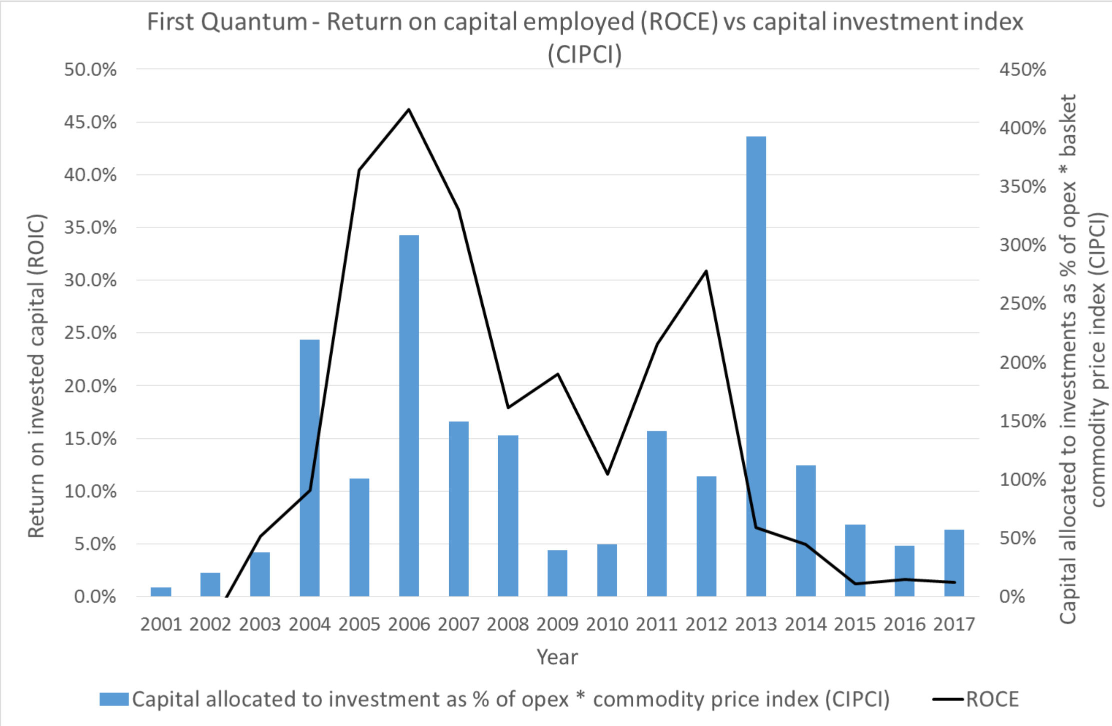

Figure 8.18: First Quantum ROCE as a function of CIPCI for the period 2001 to 2017

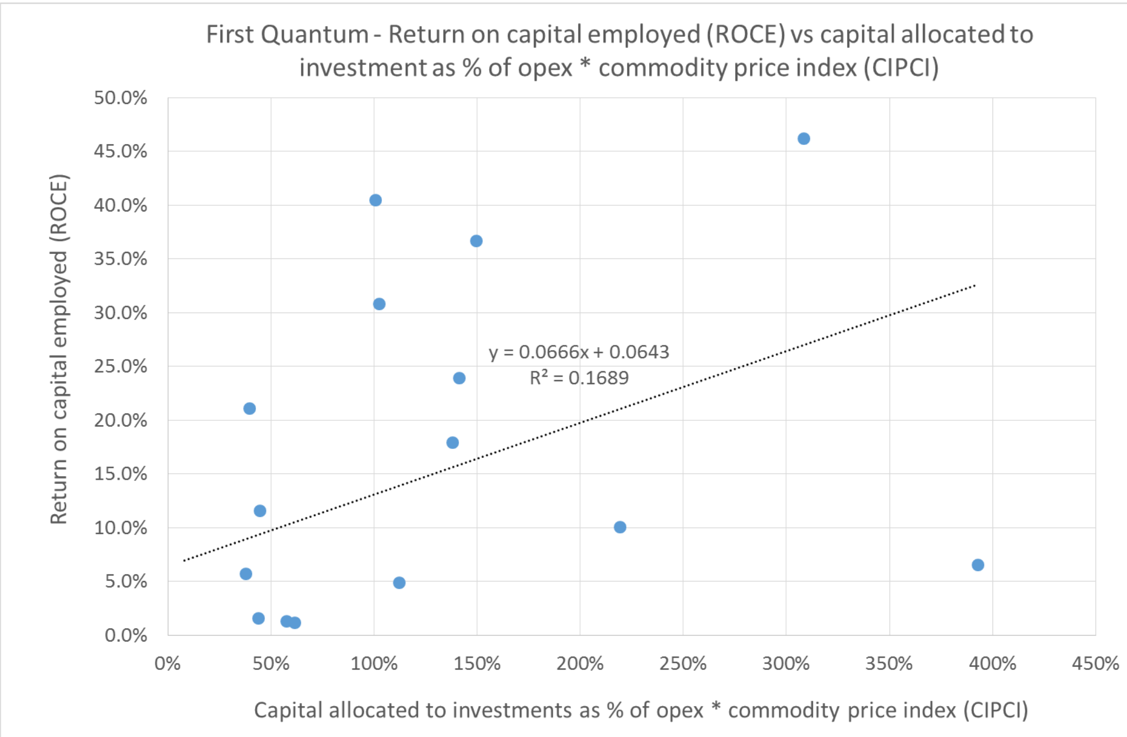

Figure 8.19: First Quantum – scatter diagram of ROCE and CIPCI for the period 2001 to 2017

Similar to the results obtained for ROIC, Figure 8.18 and Figure 8.19 indicates a moderate positive linear relationship between ROCE and CIPCI, with a Pearson correlation coefficient of 0.41. The moderate positive linear relationship indicates that amount of capital allocated had little impact on the return on incremental capital realised. The coefficient of determination (R^2) obtained from Figure 8.19 is 0.17, which indicates that 17% of the variations in ROCE can be explained by variations in CIPCI. Figure 8.20 indicates CIPCI and ROCE achieved three years after the capital investment was made. The linear relationship between the two variables is shown in a scatter diagram in Figure 8.21.

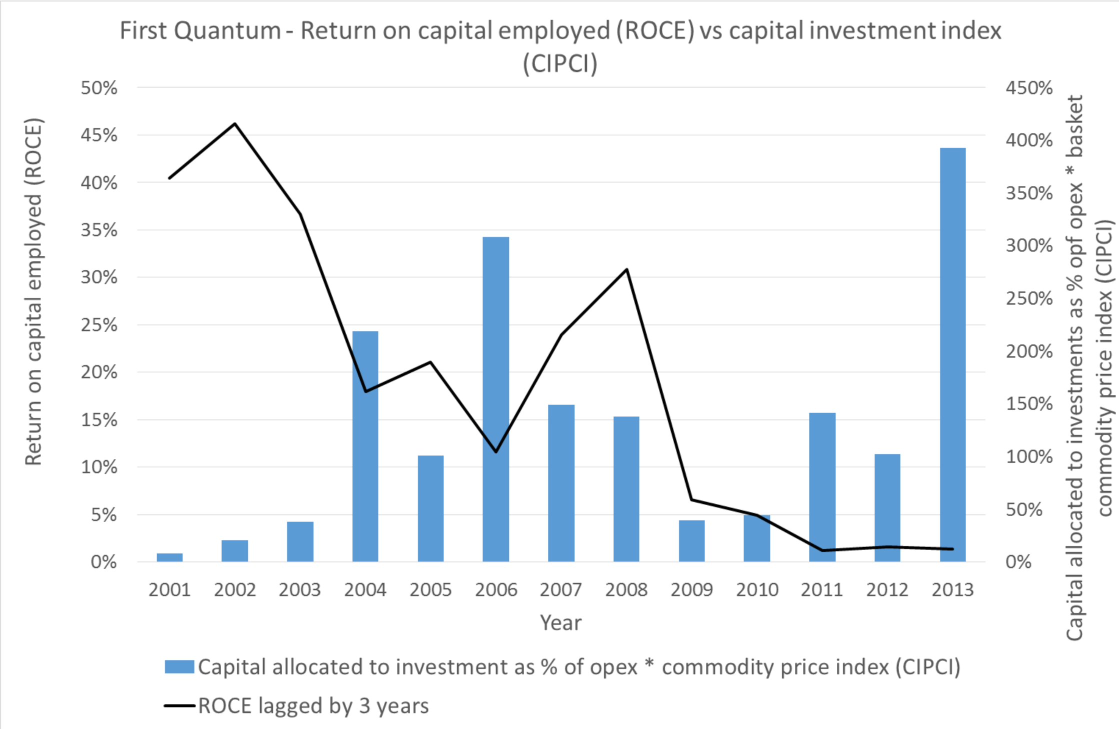

Figure 8.20: First Quantum ROCE lagged by 3 years as a function of CIPCI, 2001 – 2013

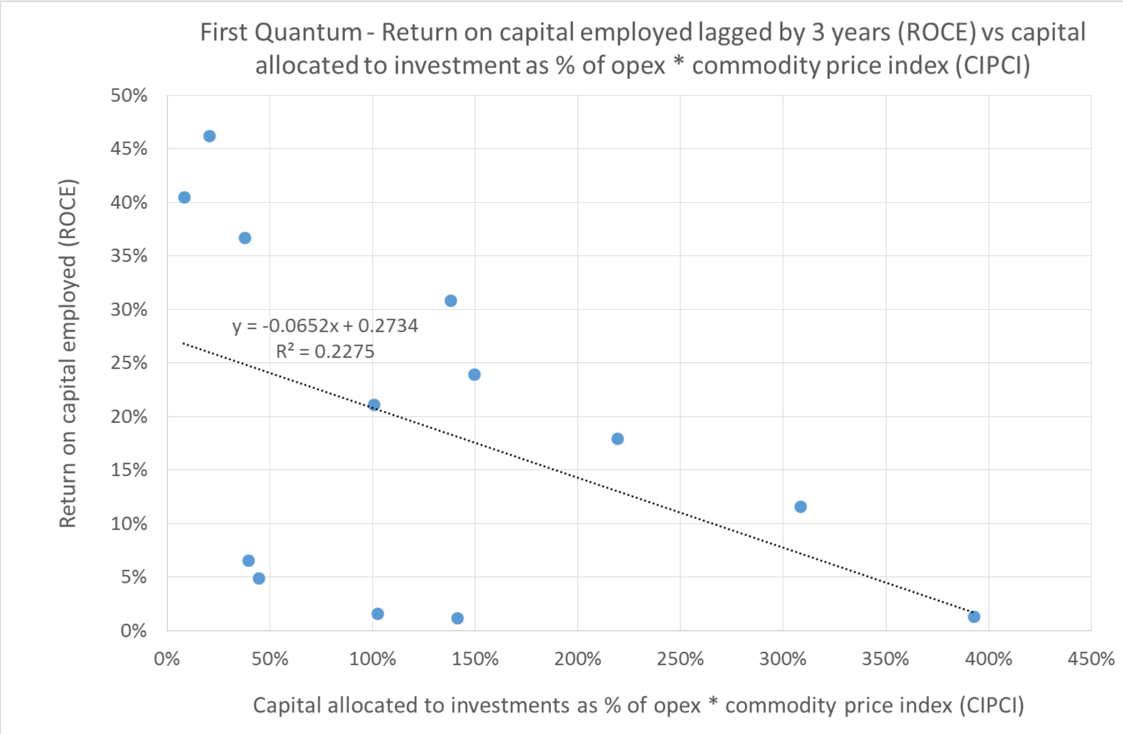

Figure 8.21: First Quantum – scatter diagram of ROCE lagged by 3 years and CIPCI, 2001 – 2013

Similar to the results obtained with the other companies analysed, ROCE obtained three years after the capital investment was made, had a moderate negative Pearson correlation coefficient of -0.48 with CIPCI, and a coefficient of determination (R^2) of 0.23. This negative linear relationship is similar to the results obtained for the other four mining companies. The moderate negative linear relationship indicates that capital investments made during periods of low commodity prices, typically achieved higher returns three years after the investment was made, and vice versa.

8.12 Chapter summary

Most of First Quantum's revenue over the analysis period from 2001 to 2017 was derived from the production and sale of copper. As a growth company First Quantum was able to achieve substantial production volume growth between 2001 and 2017 on the back of high allocation of capital to growth activities. The high production growth rates enabled First Quantum to increase real term

EBITDA from US$4 million in 2002 to US$811 million in 2017. Over the same period shareholders' equity increased by 199 times from US$20 million in 2001 to US$8.9 billion in 2017.

The strong production volume growth rates were achieved through consistent allocation of capital to investments throughout the commodity price cycle, equal to an average of 107.7% of operational costs over the analysis period. This is in contrast with the other four mining companies where the average capital allocation to investments were between 23% to 49% of operational costs. There is little if any correlation between the basket commodity price index and the value of capital commitments. This indicates that allocation of capital towards growth activities were done consistently throughout the commodity price cycle.

Similar to results obtained for the other four mining companies there was a negative correlation between the CIPCI and the return on investment achieved three years after the investment was made. First Quantum also typically achieved higher returns on capital allocations during periods of relatively low commodity prices, compared to capital allocations done during periods of high commodity prices. A summary of the results and conclusions from the research analysis conducted on the five mining companies are provided in the next chapter. A list of recommendations for further research are also provided in Chapter 9.

9 CONCLUSIONS AND RECOMMENDATIONS

9.1 Chapter overview

In this chapter a summary of the results from the research study for the five companies is given. A number of observations are presented, specifically focussed on the variance in results between the different companies. Conclusions from the analysis of capital allocation by the five mining companies are presented and recommendations made on the optimal capital allocation strategy that unlocks more value over the long term.

9.2 Summary of results from the research study

Table 9.1 provides a summary of the results obtained from the capital allocation analysis performed on the five mining companies from 2001 to 2017. This summary provides the capital allocated to capital expenditure and investment activities as a percentage of total operational costs, and the ROCE and ROIC achieved. The success of the capital allocation is measured by the CAGR achieved on production volume growth and shareholder equity respectively. For each of the metrics the mean, standard deviation and Pearson correlation coefficient with the basket commodity price index are provided. In item number 1.0 on Table 9.1 only stay-in-business and expansion capital were included in the calculation. In item number 2.0 on the Table, total capital expenditure and net cash flows allocated towards acquisitions and disposals were included in the calculation. The companies are ranked based on the CAGR achieved in shareholder equity growth.

Table 9.1: Summary of results obtained from the capital allocation study for the period 2001 to 2017

Source: Anglo American (2001 – 2017), BHP (2001 – 2017), Rio Tinto (2001 – 2017), Vale (2001 – 2017), First Quantum (2001 - 2017)

No.	Description	Unit	Anglo American	BHP	Rio Tinto	Vale	First Quantum
1.0	**Capital expenditure as % of operational costs**						
1.1	Mean	%	21.3%	34.2%	23.3%	48.9%	82.1%
1.2	Standard deviation (Std dev)	%	6.4%	14.6%	9.0%	14.8%	80.0%
1.3	Std dev as % of mean	%	30.0%	42.7%	38.8%	30.3%	97.5%
1.4	Pearson correlation coefficient with commodity basket price index		0.78	0.58	0.54	0.64	-0.17
2.0	**Net capital allocated to investment activities as % of operational costs**						
2.1	Mean	%	23.2%	34.5%	32.0%	49.0%	107.7%
2.2	Standard deviation (Std dev)	%	13.0%	19.7%	46.3%	41.0%	88.6%
2.3	Std dev as % of mean	%	55.9%	57.2%	144.7%	83.6%	82.3%
2.4	Pearson correlation coefficient with commodity basket price index		0.42	0.66	0.21	0.25	-0.05
3.0	**Capital allocated to investment as % of opex * commodity price index (CIPCI)**						
3.1	Mean	%	26.1%	41.4%	36.3%	64.7%	104.2%
3.2	Standard deviation (Std dev)	%	18.6%	32.0%	54.8%	60.3%	80.0%
3.3	Std dev as % of mean	%	71.3%	77.1%	151.0%	93.1%	76.8%
3.4	Pearson correlation coefficient with commodity basket price index		0.69	0.82	0.39	0.60	0.44
4.0	**ROIC**						
4.1	Mean	%	15.0%	22.2%	19.4%	17.2%	13.5%
4.2	Standard deviation (Std dev)	%	4.8%	7.3%	5.4%	5.5%	12.5%
4.3	Std dev as % of mean	%	31.7%	33.1%	27.9%	31.7%	92.0%
4.4	Pearson correlation coefficient with commodity basket price index		0.42	0.62	0.06	0.09	0.42
5.0	**ROCE**						
5.1	Mean	%	15.0%	22.4%	17.9%	16.1%	14.2%
5.2	Standard deviation (Std dev)	%	7.8%	11.3%	7.2%	7.0%	17.0%
5.3	Std dev as % of mean	%	51.8%	50.7%	40.0%	43.6%	120.0%
5.4	Pearson correlation coefficient with commodity basket price index		0.41	0.67	0.15	0.12	0.57
6.1	Increase in production volume index	%	21%	47%	40%	165%	1217%
6.2	CAGR - Production volume index	%	1.2%	2.5%	2.1%	6.3%	17.5%
7.1	Shareholders equity at end 2017	$ millions	22 972	57 258	44 711	44 772	8 960
7.2	Increase in real terms shareholders equity	%	29%	178%	350%	597%	14290%
7.3	CAGR - shareholders equity (real terms)	%	1.6%	6.6%	9.9%	12.9%	36.4%
8	Rank - shareholders equity growth		5	4	3	2	1

Table 9.1 indicates that First Quantum achieved the highest CAGR in shareholders' equity of 36.4%. However, this was achieved from a very low base in comparison with the other four mining companies. First Quantum also achieved the highest CAGR in the production volume index with 17.5%, which is

substantially better than the next highest of 6.3% from Vale. This was achieved due to First Quantum allocating the highest average annual capital to investment activities equal to 107.7% of annual operational costs.

First Quantum also had the lowest Pearson correlation coefficient between net capital allocated to investments and prevailing commodity prices. This indicates that First Quantum allocated capital more consistently toward investment activities throughout the commodity price cycle. This is also reflected in First Quantum's mean CIPCI index of 104.2% which is marginally lower than the average capital allocated to investments as a percentage of operational costs of 107.7%. This indicates that on average more capital allocations were made at times when the prevailing commodity price basket was lower than the average commodity price basket. The other four mining companies, respectively all have a higher mean CIPCI indices than the mean percentages of capital allocated to investment as percentage of operational costs. This indicates that Anglo American, BHP, Rio Tinto and Vale allocated more capital towards investments during periods when the prevailing commodity prices were higher than the average basket commodity price over the analysis period.

Anglo American achieved the lowest annual growth rate in the production unit index with a CAGR of 1.6%. This was achieved through a mean capital allocation of 23.2% of annual operational costs which was the lowest of all the five companies. From this result one can reason that circa 20% of annual operational costs are required to be allocated to stay-in-business and expansion capital in order to maintain steady production rates. This observation is supported by results from BHP and Rio Tinto where capital allocations of circa 30% of annual operational costs toward growth investments realised a marginally higher production volume index CAGR of approximately 2%.

Notably, whilst First Quantum achieved the highest shareholder equity CAGR, it also achieved the lowest mean ROCE and ROIC. This could potentially be due to the quality of the existing large long life operational assets already in operation in Anglo American, BHP, Rio Tinto and Vale. In order to determine a better understanding of the return on incremental capital invested one would have to extract the earnings contribution from the existing assets and only focus on the incremental operational returns from the assets in which the capital investments were made.

9.3 Conclusions

From the analysis of the merger, acquisitions and disposals made by five diversified mining companies it was observed that during periods of higher commodity prices, the mining companies primarily focussed on volume growth. For all five companies there is a very strong correlation between the value of capital approvals and the average basket commodity price of the minerals produced. In order to expedite projects there were a number of instances of substantial overspend on capital projects, which led to significant impairment charges during the subsequent decline in commodity prices.

In a declining commodity price environment the mining companies focussed on rationalisation of mining projects and operations, and disposal of assets that do not meet minimum investment criteria. During these periods there were limited capital allocation towards growth projects, and most capital allocation decisions were directed towards reduction of net debt. A common trend found is that more capital was allocated towards growth projects during historical high commodity prices, and during subsequent lower commodity prices capital allocation was directed towards reduction of net debt and disposal of loss making assets.

Notably, there was a strong direct correlation between capital allocated to growth opportunities as a percentage of operational expenditure, and the CAGR increase achieved in shareholder equity. First Quantum achieved a 14,290% increase in shareholders' equity from 2001 to 2017 by allocating capital equal to

107.7% of operational costs to growth opportunities. In contrast Anglo American achieved a 29% increase in shareholder equity over the same period by allocating capital equal to an average of 23.2% of operational costs to growth opportunities. Results from Anglo American, BHP and Rio Tinto indicate that mining companies should allocate the equivalent of circa 20% of operational costs towards SIB capital expenditure in order to sustain production levels. Capital allocations greater than 30% of operational costs to SIB and expansion capital expenditure are required to achieve meaningful production volume growth.

9.4 Recommendations to mining companies for better return on capital invested

From the conclusions obtained from the analysis the following recommendations are made for a capital allocation strategy to increase the probability of unlocking value over the long term. Firstly, mining companies should have clear capital allocation frameworks which are guided by the respective companies' strategic objectives. The frameworks should clearly indicate the hierarchy of importance when allocating capital to different areas. This hierarchy of capital allocation areas will vary from company to company depending on the company's strategic objectives. For example if maintaining a strong balance sheet is a strategic objective, then maintaining a gearing ratio below a certain threshold may be a priority over allocating capital to growth projects. Secondly mining companies should clearly identify the minimum investment criteria to be met before capital is allocated to an investment. The minimum investment criteria should be aligned with each company's strategic objectives. Lastly mining companies should aim to consistently invest capital throughout the commodity price cycle, and be cautious of over allocating capital towards growth projects during periods of high commodity prices.

9.5 Recommendations for further studies

The results from the research study indicates that there may be a correlation between return on investment and the timing of the capital investment in relation to the position in the commodity price cycle. However, the results obtained for the five mining houses were strongly influenced by operational returns from existing operations, which made it difficult to determine the return realised on incremental capital expenditure. In order to further test this hypothesis it is recommended that the returns realised on major individual projects are analysed, as opposed to the overall company returns which includes returns from existing operational mines. For this the capital costs and net cash flows realised from individual projects will have to be determined. This should be possible for most major projects completed by the five public listed mining companies, as the production ramp-up and unit costs for each project are typically provided in annual production reports, which should make it possible to reconstruct the cash flows for each project. This analysis should allow for a more accurate test of the hypothesis that mining companies can potentially obtain better project returns by adopting a contrarian investment approach in relation to prevailing commodity prices.

In addition, it is recommended that the WACC for the mining companies are calculated on an annual basis and compared against the returns on capital employed. Returns on capital employed greater that the WACC indicates value creation, whilst returns lower than the WACC are indicative of value destruction.

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11 APPENDICES

Appendix 11.1: Anglo American economic data - part one

(Source: Anglo American, 2001 - 2017)

Description	**Units**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
US$ inflation index		1.03	1.04	1.07	1.10	1.13	1.17	1.20	1.25	1.25	1.27	1.31	1.33	1.35	1.37	1.38	1.39	1.42
Year-end open capital commitments $ millions	$ millions	543	337	873	825	1 247	1 886	2 373	3 465	2 877	2 669	2 131	2 792	3 391	1 936	1 168	1 317	1 444
Capital expenditure	$ millions	1 787	2 139	3 025	3 129	3 361	3 750	3 932	5 147	4 607	5 280	6 203	6 030	6 261	6 089	4 177	2 387	2 228
Capital expenditure as % of revenue	%	9%	10%	12%	12%	11%	11%	15%	20%	22%	19%	20%	21%	21%	22%	20%	11%	8%
Capital expenditure as % of operating costs	%	15%	17%	18%	14%	14%	22%	23%	28%	28%	27%	30%	26%	27%	27%	23%	13%	11%
Capital expenditure (real 2000 terms)	$ millions	1 738	2 048	2 832	2 852	2 963	3 203	3 266	4 117	3 698	4 170	4 749	4 523	4 628	4 429	3 035	1 713	1 566
Net cash outflow from acquisition	$ millions	718	2 911	1 469	1 135	327	198	1 934	5 887	36	519	47	4 816	-	81	80	51	86
Acquisitions as % of revenue	%	4%	14%	6%	4%	1%	1%	8%	22%	0%	2%	0%	17%	0%	0%	0%	0%	0%
Net cash inflow from disposals	$ millions	-135	-24	-3	-1 698	-432	-998	-822	-1 554	-2 818	-2 859	-610	-100	-13	-44	-1 745	-1 082	-71
Disposals as % of revenue	%	-1%	0%	0%	-6%	-1%	-3%	-3%	-6%	-14%	-10%	-2%	0%	0%	0%	-9%	-5%	0%
Net cash from acquisitions and disposals	$ millions	583	2 887	1 466	-563	-105	-800	1 112	4 333	-2 782	-2 340	-563	4 716	-13	37	-1 665	-1 031	15
Net cash used in investing activities	*$ millions*	***2 370***	***5 026***	***4 491***	***2 566***	***3 256***	***2 950***	***5 044***	***9 480***	***1 825***	***2 940***	***5 640***	***10 746***	***6 248***	***6 126***	***2 512***	***1 356***	***2 243***
Net capital allocated to investing activities as % of	$ millions	**12%**	**25%**	**18%**	**10%**	**11%**	**9%**	**20%**	**36%**	**9%**	**11%**	**18%**	**37%**	**21%**	**23%**	**12%**	**6%**	**9%**
Net capital allocated to investing activities as % of	$ millions	**20%**	**39%**	**27%**	**11%**	**14%**	**17%**	**30%**	**52%**	**11%**	**15%**	**27%**	**46%**	**27%**	**27%**	**14%**	**8%**	**11%**
New capital commitments $ millions	$ millions		1 933	3 561	3 081	3 783	4 389	4 419	6 239	4 019	5 072	5 665	6 691	6 860	4 634	3 409	2 536	2 355
New capital commitments $ millions (real 2000 terms)	$ millions		1 850	3 333	2 809	3 336	3 749	3 670	4 990	3 226	4 005	4 337	5 018	5 071	3 371	2 477	1 820	1 655
Revenue	$ millions	19 282	20 497	24 909	26 268	29 434	33 072	25 470	26 311	20 858	27 960	30 580	28 761	29 342	27 073	20 455	21 378	26 243
Revenue (real 2000 terms)	$ millions	18 749	19 622	23 317	23 946	25 953	28 249	21 153	21 044	16 742	22 080	23 410	21 571	21 689	19 693	14 861	15 338	18 441
Operational costs	$ millions	12 140	12 757	16 740	22 627	24 090	16 943	16 952	18 330	16 481	19 452	20 912	23 187	23 174	22 560	18 417	18 047	21 001
Operational costs (real 2000 terms)	$ millions	11 804	12 212	15 670	20 627	21 241	14 472	14 079	14 660	13 229	15 361	16 009	17 391	17 130	16 410	13 381	12 948	14 758
Operational costs as % of revenue	%	63%	62%	67%	86%	82%	51%	67%	70%	79%	70%	68%	81%	79%	83%	90%	84%	80%
Total capital (Sum of shareholders funds, net debt and minority interest)	$ millions	16 474	24 142	32 415	36 846	33 115	31 055	30 244	33 096	39 349	45 355	44 563	52 248	48 016	45 048	34 243	32 812	33 383
Minority interest	$ millions	1 607	2 304	3 396	4 588	3 957	2 856	1 869	1 535	1 948	3 732	4 097	6 127	5 693	5 760	4 773	5 309	5 910
Shareholders equity	$ millions	12856	16261	20394	23125	23621	24271	22461	20221	26121	34239	39092	37611	31671	26417	16569	19016	22972
Net debt	$ millions	2 011	5 577	8 625	9 133	5 537	3 928	5 914	11 340	11 280	7 384	1 374	8 510	10 652	12 871	12 901	8 487	4 501
Gearing ratio %	%	16%	34%	42%	39%	23%	16%	26%	56%	43%	22%	4%	23%	34%	49%	78%	45%	20%
New capital commitments as % of total capital	%		8.0%	11.0%	8.4%	11.4%	14.1%	14.6%	18.9%	10.2%	11.2%	12.7%	12.8%	14.3%	10.3%	10.0%	7.7%	7.1%
New capital commitments as % of turnover	%		9.4%	14.3%	11.7%	12.9%	13.3%	17.3%	23.7%	19.3%	18.1%	18.5%	23.3%	23.4%	17.1%	16.7%	11.9%	9.0%
Capital expenditure as percentage of total capital	%		8.9%	9.3%	8.5%	10.1%	12.1%	13.0%	15.6%	11.7%	11.6%	13.9%	11.5%	13.0%	13.5%	12.2%	7.3%	6.7%

Appendix 11.2: Anglo American economic data - part two

(Source: Anglo American, 2001 - 2017)

Description	Units	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Profit before tax and special items	$ millions	3 428	3 153	2 586	4 213	5 612	9 159	9 021	8 832	4 422	9 109	10 626	5 610	6 135	4 511	2 038	3 393	5 346
Impairment charges	$ millions	-513	-127	-286	25	-186	-500	-201	-206	-1 909	-122	-154	-5 820	-2 474	-4 246	-5 957	-1 354	111
Profit after tax	$ millions	2 181	2 111	1 837	2 933	4 329	6 396	6 663	6 287	3 117	6 410	7 885	4 122	4 274	3 244	1 193	2 651	4 022
Net cash inflows from operating activities	$ millions	3 539	3 618	3 184	5 187	6 781	8 310	7 264	8 065	4 087	7 727	9 362	5 919	6 792	6 111	3 977	5 399	8 049
Net cash flows to net debt ratio	$ millions	176%	65%	37%	57%	122%	212%	123%	71%	36%	105%	681%	70%	64%	47%	31%	64%	179%
Net cash flows in-flows from operating activities as %	%	18%	18%	13%	20%	23%	25%	29%	31%	20%	28%	31%	21%	23%	23%	19%	25%	31%
Net total cash in-flows from operating activities and	%	19%	18%	13%	26%	25%	28%	32%	37%	33%	38%	33%	21%	23%	23%	28%	30%	31%
EBITDA	$ millions	4 647	4 792	4 785	7 031	8 959	12 197	12 132	11 847	6 930	11 983	13 348	8 860	9 520	7 832	4 854	6 075	8 823
EBITDA (real 2000 terms)	$ millions	4 518	4 587	4 479	6 409	7 899	10 418	10 076	9 475	5 562	9 463	10 218	6 645	7 037	5 697	3 527	4 359	6 200
Income taxes	$ millions	1 394	1 045	762	923	1 275	2 518	2 693	2 451	1 117	2 809	2 860	393	1 274	1 265	388	698	1 446
NOPAT	$ millions	3 253	3 747	4 023	6 108	7 684	9 679	9 439	9 396	5 813	9 174	10 488	8 467	8 246	6 567	4 466	5 377	7 377
Sales	$ millions	19 282	20 497	24 909	26 268	29 434	33 072	25 470	26 311	20 858	27 960	30 580	28 761	29 342	27 073	20 455	21 378	26 243
NOPAT/ Sales	%	17%	18%	16%	23%	26%	29%	37%	36%	28%	33%	34%	29%	28%	24%	22%	25%	28%
Dividends paid to shareholders	$ millions	714	732	741	827	1 137	2 888	1 538	1 550	0	302	818	970	1 078	1 099	1 078	0	618
Share buy-backs	$ millions	0	0	0	0	0	2 010	2 383	0	0	0	0	0	0	0	0	0	0
Total dividends paid and share buy-backs	$ millions	714	732	741	827	1 137	4 898	3 921	1 550	0	302	818	970	1 078	1 099	1 078	0	618
Total distributions to shareholders as % of revenue	%	3.7%	3.6%	3.0%	3.1%	3.9%	14.8%	15.4%	5.9%	0.0%	1.1%	2.7%	3.4%	3.7%	4.1%	5.3%	0.0%	2.4%
Total distributions to shareholders as % of total assets	%	2.8%	2.2%	1.7%	1.5%	2.2%	10.8%	8.9%	3.1%	0.0%	0.5%	1.1%	1.3%	1.5%	1.7%	2.1%	0.0%	1.1%
Invested capital	$ millions	21 593	29 252	38 503	47 252	44 435	38 524	38 419	43 123	50 442	59 979	64 956	69 834	64 922	60 901	47 796	45 430	48 432
Invested capital less cash	$ millions	20 678	28 182	37 409	45 166	41 005	35 520	35 290	40 352	47 173	53 578	53 224	60 740	57 218	54 153	40 901	39 379	40 632
Sales/ Invested capital		89%	70%	65%	56%	66%	86%	66%	61%	41%	47%	47%	41%	45%	44%	43%	47%	0.54185
ROCE	*%*	***19.5%***	***14.0%***	***10.1%***	***10.3%***	***15.1%***	***26.9%***	***32.4%***	***28.4%***	***10.1%***	***16.7%***	***17.3%***	***9.3%***	***10.5%***	***8.3%***	***4.8%***	***8.6%***	***13.3%***
ROIC	*%*	***15.1%***	***12.8%***	***10.4%***	***12.9%***	***17.3%***	***25.1%***	***24.6%***	***21.8%***	***11.5%***	***15.3%***	***16.1%***	***12.1%***	***12.7%***	***10.8%***	***9.3%***	***11.8%***	***15.2%***
Capital allocated to investment as % of opex * commodity price index (CIPCI)	*%*	**14%**	**30%**	**21%**	**9%**	**12%**	**20%**	**39%**	**70%**	**11%**	**21%**	**44%**	**62%**	**33%**	**29%**	**12%**	**6%**	**10%**

Appendix 11.3: Anglo American balance sheet data and ROCE calculation

(Source: Anglo American, 2001 - 2017)

Description	Unit	2 001	2 002	2 003	2 004	2 005	2 006	2 007	2 008	2 009	2 010	2 011	2 012	2 013	2 014	2 015	2 016	2 017
Net working capital	$ millions	3 200	3 035	4 029	6 061	5 692	5 073	4 377	2 965	5 165	8 001	12 084	11 845	9 916	9 199	9 580	7 730	8 604
Total current assets	$ millions	7 136	7 364	9 253	12 260	13 147	11 844	9 962	9 305	10 411	14 348	19 244	17 998	16 159	14 308	13 770	12 449	14 604
Non-interest bearing current liabilities	$ millions	-3 936	-4 329	-5 224	-6 199	-7 455	-6 771	-5 585	-6 340	-5 246	-6 347	-7 160	-6 153	-6 243	-5 109	-4 190	-4 719	-6 000
Total non-current assets	$ millions	18 393	26 217	34 474	41 191	38 743	33 451	34 042	40 158	45 277	51 978	52 872	57 989	55 006	51 702	38 216	37 700	39 828
Invested capital	$ millions	21 593	29 252	38 503	47 252	44 435	38 524	38 419	43 123	50 442	59 979	64 956	69 834	64 922	60 901	47 796	45 430	48 432
Cash or cash equivalents	$ millions	915	1 070	1 094	2 086	3 430	3 004	3 129	2 771	3 269	6 401	11 732	9 094	7 704	6 748	6 895	6 051	7 800
Invested capital excluding cash	$ millions	20 678	28 182	37 409	45 166	41 005	35 520	35 290	40 352	47 173	53 578	53 224	60 740	57 218	54 153	40 901	39 379	40 632
ROCE Calculation																		
EBIT	$ millions	3 766	3 830	3 475	4 448	6 376	9 832	10 551	10 085	4 957	9 763	11 095	6 253	6 620	4 933	2 223	3 766	6 247
EBITDA	$ millions	4 647	4 792	4 785	7 031	8 959	12 197	12 132	22 317	14 312	25 798	28 925	19 595	20 953	18 840	12 058	12 823	20 492
less depreciation and amortisiation	$ millions	-881	-962	-1 310	-2 583	-2 583	-2 365	-1 581	-1 762	-3 427	-3 437	-3 972	-4 624	-4 791	-4 860	-4 645	-4 794	-4 375
Total assets	$ millions	25 529	33 581	43 727	53 451	51 890	45 295	44 004	49 463	55 688	66 326	72 116	75 987	71 165	66 010	51 986	50 149	54 432
Current liabilities	$ millions	6 237	6 247	9 318	10 153	9 550	8 799	11 480	13 962	6 745	7 882	8 008	8 638	8 351	6 727	5 839	6 525	7 351
Capital employed	$ millions	19 292	27 334	34 409	43 298	42 340	36 496	32 524	35 501	48 943	58 444	64 108	67 349	62 814	59 283	46 147	43 624	47 081
Return on capital employed (ROCE)	%	**20%**	**14%**	**10%**	**10%**	**15%**	**27%**	**32%**	**28%**	**10%**	**17%**	**17%**	**9%**	**11%**	**8%**	**5%**	**9%**	**13%**

Appendix 11.4: Anglo American production and commodity prices - part one

(Source: Anglo American, 2001 - 2017)

Description	Units	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Average
Rand/US$ Exchange Rate		8.62	10.48	7.55	6.44	6.37	6.77	7.05	8.27	8.41	7.32	7.26	8.21	9.65	10.85	12.78	14.7	13.31	**9.06**
Sterling/US$ Exchange Rate		0.69	0.67	0.61	0.55	0.55	0.54	0.5	0.54	0.64	0.65	0.62	0.63	0.64	0.61	0.65	0.74	0.78	**0.62**
Euro/US$ Exchange Rate		1.12	1.06	0.88	0.8	0.8	0.8	0.73	0.68	0.72	0.75	0.72	0.78	0.75	0.75	0.9	0.9	0.89	**0.83**
Australian Dollar/US$ Exchange Rate		1.93	1.84	1.53	1.36	1.31	1.33	1.19	1.17	1.26	1.09	0.97	0.97	1.03	1.11	1.33	1.34	1.3	**1.30**
Chilean Peso/US$ Exchange Rate				690	609	559	530	522	524	559	510	484	486	495	571	655	676	649	**567.93**
Brazilian real									1.84	2	1.76	1.67	1.95	2.16	2.35	3.34	3.48	3.19	**2.37**
US CPI Inflation		2.8%	1.6%	2.3%	2.7%	3.4%	3.2%	2.8%	3.8%	-0.4%	1.6%	3.2%	2.1%	1.5%	1.6%	0.1%	1.3%	2.1%	
US CPI Index		1.03	1.04	1.07	1.10	1.13	1.17	1.20	1.25	1.25	1.27	1.31	1.33	1.35	1.37	1.38	1.39	1.42	
Commodity Prices (Nominal)																			
Average market prices for the year																			
Diamonds	US$/carrat	118	152	150	150	150	137	142	135	156	178	236	237	198	198	207	187	175	**171**
Gold	US$/oz	272	310	363	409	445	604												**401**
Platinum	US$/oz	531	541	692	847	897	1 142	1 304	1 585	1 211	1 610	1 725	1 555	1 487	1 385	1 051	989	950	**1 147**
Palladium	US$/oz	597	336	201	231	201	321	355	355	266	527	736	647	725	803	691	615	871	**499**
Rhodium	US$/oz	1 606	838	530	991	2 056	4 571	6 200	6 564	1 592	2 453	2 022	1 275	1 067	1 173	932	681	1 097	**2 097**
Copper	US cents/lb	72	71	81	130	167	305	323	315	234	342	400	361	332	311	249	221	280	**247**
Nickel	US cents/lb	267	307	437	628	668	1 095	1 686	953	667	989	1 035	794	680	765	536	436	472	**730**
Zinc	US cents/lb	41	35	38	48	63	148	147	85	75	98	0	0	0	0	0	0	0	**71**
Lead	US cents/lb	22	21	23	40	44	58	118	95	78	97	0	0	0	0	0	0	0	**54**
Iron ore (FOB Australia)	US$/tonne			20	26	28	33	37	62	68	136	160	122	135	97	56	58	71	**74**
Thermal Coal (FOB South Africa)	US$/tonne	37	28	37	52	55	50	45	80	64	92	116	93	80	72	57	69	84	**65**
Thermal Coal (FOB Australia)	US$/tonne	37	28	37	52	55	50	45	80	72	99	121	94	84	71	59	64	89	**67**
Hard coking coal (FOB Australia)	US$/tonne	177	191	178	124	99	113	115	161	172	191	289	210	159	125	102	114	188	**159**
European eucalyptic pulp price (CIF)	US$/tonne	490	452	500	520	582	638	0	0	0	0	0	0	0	0	0	0	0	**455**
Niobium	US$/tonne	11 471	11 818	11 818	12 571	12 250	14 043	22 553	30 652	36 078	38 000	38 723	38 723	38 723	39 130	24 130	29 783	0	**25 654**
Phosphates	US$/tonne	170	170	182	224	279	313	400	667	386	460	539	536	468	443	395	368	0	**375**
Managanese Ore	US$/tonne	100	100	107	123	205	244	244	507	355	301	300	234	246	219	155	191	287	**231**

Appendix 11.5: Anglo American production and commodity prices - part two

(Source: Anglo American, 2001 - 2017)

Description	**Units**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**Average**
Commodity Prices (Real 2000 Prices)																			
Diamonds		115	145	141	137	133	117	118	108	125	141	180	178	146	144	150	134	123	**137**
Gold	US$/oz	264	297	340	373	392	516	0	0	0	0	0	0	0	0	0	0	0	**364**
Platinum	US$/oz	516	518	648	772	791	975	1 083	1 268	972	1 271	1 321	1 166	1 099	1 007	764	710	668	**915**
Palladium	US$/oz	580	322	188	211	177	274	295	284	214	416	563	485	536	584	502	441	612	**393**
Rhodium	US$/oz	1 562	802	496	903	1 813	3 904	5 149	5 250	1 278	1 937	1 548	956	789	853	677	489	771	**1 716**
Copper	US cents/lb	70	68	76	119	147	261	268	252	188	270	306	271	245	226	181	159	197	**194**
Nickel	US cents/lb	260	294	409	572	589	935	1 400	762	535	781	792	596	503	556	389	313	332	**589**
Zinc	US cents/lb	40	34	36	44	56	126	122	68	60	77	0	0	0	0	0	0	0	**66**
Lead	US cents/lb	21	20	22	36	39	50	98	76	63	77	0	0	0	0	0	0	0	**50**
Iron ore (FOB Australia)	US$/tonne	0	0	19	24	25	29	30	49	55	107	122	92	100	71	41	42	50	**57**
Hard coking coal (FOB Australia)	US$/tonne	172	183	167	113	87	96	95	128	138	151	221	158	118	91	74	82	132	**130**
Thermal Coal (FOB South Africa)	US$/tonne	36	27	35	47	48	43	37	64	51	73	89	70	59	52	41	50	59	**52**
Thermal Coal (FOB Australia)	US$/tonne	36	27	35	47	48	43	37	64	58	78	93	71	62	52	43	46	63	**53**
Niobium	US$/tonne	11 063	11 063	11 063	11 460	10 801	11 995	18 731	24 516	28 959	30 009	28 624	28 624	28 624	28 463	17 531	21 368	0	**20 181**
Phosphates	US$/tonne	170	170	170	204	246	267	332	533	310	363	412	402	346	322	287	264	0	**300**
Managanese Ore	US$/tonne	100	100	100	112	181	208	203	405	285	238	230	176	182	159	112	137	202	**184**
Production Volumes																			
Diamonds	carats (000)	17 415	18 090	19 755	21 150	22 055	23 011	21 659	23 001	11 070	14 849	14 098	16 962	26 485	27 714	24 388	23 238	33 454	**21 082**
Gold	troy oz (000)	7 052	6 463	6 487	6 259	6 166	3 317	98	79	91	81	105	105	100	96	113	108	108	**2 166**
Platinum	troy oz (000)	2 146	2 294	2 356	2 498	2 502	2 864	2 474	2 387	2 452	2 570	2 530	2 379	2 380	1 890	2 459	2 335	2 583	**2 417**
Palladium	troy oz (000)	1 076	1 137	1 214	1 332	1 377	1 563	1 390	1 319	1 361	1 449	1 431	1 396	1 381	1 225	1 595	1 464	1 627	**1 373**
Rhodium	troy oz (000)	204	216	237	259	334	332	329	299	350	329	338	311	295	229	305	317	298	**293**
Copper	tonnes (000)	435	467	709	766	646	655	666	650	683	637	612	671	752	726	687	557	669	**646**
Nickel	tonnes (000)	16	22	47	47	47	48	45	36	40	39	49	57	34	37	30	45	70	**42**
Zinc	tonnes (000)	219	287	361	411	342	335	343	341	350	350	23							**305**
Lead	tonnes (000)	17	22	40	38	63	71	62	63	68	71	8							**48**
Iron ore	tonnes (million)	0	1	30	30	31	31	32	37	45	47	41	43	42	48	53	58	63	**40**
Metallurgical coal	tonnes (million)	12	13	11	10	12	11	11	15	14	16	15	18	19	21	21	21	40	**16**
Thermal coal	tonnes (million)	65	68	76	79	80	84	84	85	83	83	81	82	80	79	74	74	43	**76**
Niobium	tonnes (000)	3	3	3	4	4	5	5	5	5	4	4	4	5	5	5	5	0	**4**
Phosphates	tonnes (000)	821	735	1 040	1 169	1 036	902	1 038	982	829	1 002	1 060	1 113	1 163	1 097	1 097	973	0	**1 003**
Managanese Alloys and Ore	tonnes (000)	280	306	288	321	365	397	2 721	3 010	1 699	3 265	3 087	3 546	3 553	3 595	3 324	3 271	3 271	**2 135**

Appendix 11.6: Anglo American production and commodity prices - part three

(Source: Anglo American, 2001 - 2017)

Description	Units	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Sales revenue - Nominal																		
Diamonds	$ million	2 055	2 746	2 967	3 177	3 316	3 148	3 076	3 096	1 728	2 644	3 320	4 027	6 391	7 104	4 660	6 064	5 841
Gold	$ million	1 865	1 918	2 204	2 334	2 644	1 740								0	0	0	0
Platinum	$ million	1 139	1 241	1 630	2 116	2 244	3 271	3 226	3 783	2 969	4 138	4 364	3 699	3 538	2 617	2 584	2 309	2 454
Palladium	$ million	642	382	244	308	277	502	493	468	362	763	1 053	903	1 001	984	1 102	900	1 417
Rhodium	$ million	328	181	126	256	686	1 516	2 039	1 965	557	807	683	396	314	269	284	216	327
Copper	$ million	672	699	1 266	2 195	2 379	4 406	4 743	4 515	3 524	4 801	5 398	5 341	5 505	4 977	3 771	2 714	4 128
Nickel	$ million	89	139	427	589	615	992	1 383	597	625	824	948	678	461	638	450	694	728
Zinc	$ million	192	212	283	396	419	933	923	510	445	584	585			0	0	0	0
Lead	$ million	8	10	19	30	54	78	134	105	94	120	0			0	0	0	0
Iron ore	$ million	1 932	1 933	1 934	1 935	1 936	2 259	1 635	2 573	2 330	5 234	6 830	5 508	5 365	4 029	2 610	2 611	4 489
Metallurgical coal	$ million	2 138	2 402	1 949	1 288	1 152	1 237	1 297	2 367	1 693	2 711	3 444	3 048	2 610	2 290	1 832	2 243	3 357
Thermal coal	$ million	1 211	947	1 400	2 061	2 197	2 096	2 277	4 069	3 197	3 707	4 621	4 287	3 802	3 529	3 068	3 024	3 854
Niobium	$ million	39	39	39	44	49	66	106	141	184	152	151	170	182	180	111	137	0
Phosphates	$ million	140	125	189	262	289	282	415	655	320	461	571	597	544	486	433	358	0
Managanese Ore	$ million	28	31	499	821	634	425	665	1 526	603	983	926	831	874	788	514	625	940
Total		**12 478**	**13 005**	**15 176**	**17 813**	**18 891**	**22 950**	**22 412**	**26 369**	**18 632**	**27 929**	**32 894**	**29 485**	**30 588**	**27 891**	**21 419**	**21 896**	**27 535**
Pearson correlation coefficient - sales and price		**0.84**																
Sales revenue - Real Terms 2000																		
Diamonds	$ million	1 998	2 629	2 777	2 896	2 924	2 689	2 555	2 476	1 387	2 088	2 542	3 020	4 724	5 167	3 386	4 351	4 105
Gold	$ million	1 814	1 836	2 063	2 127	2 331	1 486	-	-	-	-	-	-	-	-	-	-	-
Platinum	$ million	1 108	1 188	1 526	1 929	1 979	2 794	2 679	3 025	2 383	3 267	3 341	2 774	2 615	1 904	1 877	1 657	1 724
Palladium	$ million	625	366	228	280	244	429	410	374	290	603	806	677	740	716	801	646	996
Rhodium	$ million	319	173	118	234	605	1 295	1 693	1 571	447	637	523	297	232	196	207	155	230
Copper	$ million	654	669	1 185	2 001	2 097	3 763	3 939	3 611	2 829	3 791	4 132	4 006	4 069	3 620	2 740	1 947	2 901
Nickel	$ million	86	133	400	537	543	847	1 149	477	502	651	726	509	341	464	327	498	512
Zinc	$ million	187	203	265	361	370	797	767	408	357	461	448	-	-	-	-	-	-
Lead	$ million	8	9	18	27	48	67	111	84	76	95	-	-	-	-	-	-	-
Iron ore	$ million	1 879	1 850	1 810	1 764	1 707	1 930	1 358	2 058	1 870	4 133	5 229	4 131	3 966	2 931	1 896	1 873	3 155
Metallurgical coal	$ million	2 079	2 300	1 825	1 174	1 016	1 057	1 077	1 893	1 359	2 141	2 637	2 286	1 929	1 666	1 331	1 609	2 359
Thermal coal	$ million	1 178	906	1 310	1 879	1 937	1 790	1 891	3 254	2 566	2 927	3 538	3 215	2 810	2 567	2 229	2 170	2 708
Niobium	$ million	38	37	37	40	43	56	88	113	148	120	116	128	135	131	81	98	-
Phosphates	$ million	136	120	177	239	255	241	345	524	257	364	437	448	402	354	315	257	-
Managanese Ore	$ million	27	29	467	748	559	363	552	1 220	484	776	709	623	646	573	373	448	661
Total		**12 133**	**12 450**	**14 206**	**16 238**	**16 656**	**19 603**	**18 614**	**21 090**	**14 955**	**22 055**	**25 182**	**22 115**	**22 610**	**20 288**	**15 562**	**15 710**	**19 349**
Pearson correlation coefficient - sales and price		**0.91**																

Appendix 11.7: Anglo American basket price index calculation - part one

(Source: Anglo American, 2001 - 2017)

Description	Units	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Commodity % Contribution to Total Sales																		
Diamonds	%	16%	21%	20%	18%	18%	14%	14%	12%	9%	9%	10%	14%	21%	25%	22%	28%	21%
Gold	%	15%	15%	15%	13%	14%	8%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Platinum	%	9%	10%	11%	12%	12%	14%	14%	14%	16%	15%	13%	13%	12%	9%	12%	11%	9%
Palladium	%	5%	3%	2%	2%	1%	2%	2%	2%	2%	3%	3%	3%	3%	4%	5%	4%	5%
Rhodium	%	3%	1%	1%	1%	4%	7%	9%	7%	3%	3%	2%	1%	1%	1%	1%	1%	1%
Copper	%	5%	5%	8%	12%	13%	19%	21%	17%	19%	17%	16%	18%	18%	18%	18%	12%	15%
Nickel	%	1%	1%	3%	3%	3%	4%	6%	2%	3%	3%	3%	2%	2%	2%	2%	3%	3%
Zinc	%	2%	2%	2%	2%	2%	4%	4%	2%	2%	2%	2%	0%	0%	0%	0%	0%	0%
Lead	%	0%	0%	0%	0%	0%	0%	1%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%
Iron ore	%	15%	15%	13%	11%	10%	10%	7%	10%	13%	19%	21%	19%	18%	14%	12%	12%	16%
Metallurgical coal	%	17%	18%	13%	7%	6%	5%	6%	9%	9%	10%	10%	10%	9%	8%	9%	10%	12%
Thermal coal	%	10%	7%	9%	12%	12%	9%	10%	15%	17%	13%	14%	15%	12%	13%	14%	14%	14%
European eucalyptic pulp price (CIF)	%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Niobium	%	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%	0%	1%	1%	1%	1%	1%	0%
Phosphates	%	1%	1%	1%	1%	2%	1%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	0%
Managanese Ore	%	0%	0%	3%	5%	3%	2%	3%	6%	3%	4%	3%	3%	3%	3%	2%	3%	3%
Commodity Price Index (Real Terms)																		
Diamonds	%	84%	106%	102%	100%	97%	85%	86%	78%	91%	102%	131%	130%	107%	105%	110%	98%	89%
Gold	%	73%	82%	93%	103%	108%	142%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Platinum	%	56%	57%	71%	84%	86%	107%	118%	139%	106%	139%	144%	128%	120%	110%	83%	78%	73%
Palladium	%	148%	82%	48%	54%	45%	70%	75%	72%	54%	106%	143%	123%	136%	149%	128%	112%	156%
Rhodium	%	91%	47%	29%	53%	106%	227%	300%	306%	74%	113%	90%	56%	46%	50%	39%	28%	45%
Copper	%	36%	35%	39%	61%	76%	134%	138%	130%	97%	139%	158%	139%	126%	116%	93%	82%	101%
Nickel	%	44%	50%	69%	97%	100%	159%	238%	129%	91%	133%	134%	101%	85%	94%	66%	53%	56%
Zinc	%	60%	51%	54%	66%	84%	191%	184%	103%	91%	117%	0%	0%	0%	0%	0%	0%	0%
Lead	%	43%	40%	43%	73%	77%	99%	196%	152%	125%	153%	0%	0%	0%	0%	0%	0%	0%
Iron ore (FOB Australia)	%	0%	0%	33%	42%	44%	50%	53%	86%	96%	189%	215%	161%	175%	124%	71%	73%	88%
Metallurgical coal	%	133%	141%	129%	87%	67%	74%	73%	99%	106%	116%	170%	121%	91%	70%	57%	63%	102%
Thermal coal	%	69%	52%	67%	91%	94%	82%	72%	123%	99%	140%	171%	135%	114%	101%	80%	95%	114%
European eucalyptic pulp price (CIF)	%	98%	89%	97%	98%	106%	112%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Niobium	%	55%	55%	55%	57%	54%	59%	93%	121%	143%	149%	142%	142%	142%	141%	87%	106%	0%
Phosphates	%	57%	57%	57%	68%	82%	89%	111%	178%	103%	121%	137%	134%	115%	107%	96%	88%	0%
Managanese Ore	%	54%	54%	54%	61%	98%	113%	110%	220%	155%	129%	125%	95%	99%	87%	61%	74%	110%

Appendix 11.8: Anglo American basket price index calculation - part two

(Source: Anglo American, 2001 - 2017)

Description	**Units**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Commodity Price Index Weighted by Sales																		
Diamonds	%	0.14	0.22	0.20	0.18	0.17	0.12	0.12	0.09	0.08	0.10	0.13	0.18	0.22	0.27	0.24	0.27	0.19
Gold	%	0.11	0.12	0.14	0.13	0.15	0.11	-	-	-	-	-	-	-	-	-	-	-
Platinum	%	0.05	0.05	0.08	0.10	0.10	0.15	0.17	0.20	0.17	0.21	0.19	0.16	0.14	0.10	0.10	0.08	0.07
Palladium	%	0.08	0.02	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.03	0.05	0.04	0.04	0.05	0.07	0.05	0.08
Rhodium	%	0.02	0.01	0.00	0.01	0.04	0.15	0.27	0.23	0.02	0.03	0.02	0.01	0.00	0.00	0.01	0.00	0.01
Copper	%	0.02	0.02	0.03	0.08	0.10	0.26	0.29	0.22	0.18	0.24	0.26	0.25	0.23	0.21	0.16	0.10	0.15
Nickel	%	0.00	0.01	0.02	0.03	0.03	0.07	0.15	0.03	0.03	0.04	0.04	0.02	0.01	0.02	0.01	0.02	0.01
Zinc	%	0.01	0.01	0.01	0.01	0.02	0.08	0.08	0.02	0.02	0.02	-	-	-	-	-	-	-
Lead	%	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	-	-	-	-	-	-	-
Iron ore (FOB Australia)	%	-	-	0.04	0.05	0.04	0.05	0.04	0.08	0.12	0.35	0.45	0.30	0.31	0.18	0.09	0.09	0.14
Metallurgical coal	%	0.23	0.26	0.17	0.06	0.04	0.04	0.04	0.09	0.10	0.11	0.18	0.13	0.08	0.06	0.05	0.06	0.12
Thermal coal	%	0.07	0.04	0.06	0.11	0.11	0.08	0.07	0.19	0.17	0.19	0.24	0.20	0.14	0.13	0.11	0.13	0.16
Niobium	%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	-
Phosphates	%	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.04	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.01	-
Managanese Ore	%	0.00	0.00	0.02	0.03	0.03	0.02	0.03	0.13	0.05	0.05	0.04	0.03	0.03	0.02	0.01	0.02	0.04
Basket price index weighted by sales		**0.73**	**0.77**	**0.78**	**0.81**	**0.86**	**1.15**	**1.32**	**1.35**	**1.00**	**1.40**	**1.62**	**1.34**	**1.23**	**1.07**	**0.88**	**0.85**	**0.97**

Appendix 11.9: BHP economic data - part one

(Source: BHP, 2001 - 2017)

Description	**Units**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
US$ inflation index		1.03	1.04	1.07	1.10	1.13	1.17	1.20	1.25	1.25	1.27	1.31	1.33	1.35	1.37	1.38	1.39	1.42
Year-end open capital commitments $ millions	$ millions	1 133	1 619	1 607	1 576	2 418	3 251	3 736	5 341	4 772	4 989	7 293	10 364	5 147	4 798	2 276	1 737	2 084
Capital expenditure	$ millions	3 635	2 621	2 355	2 832	4 024	6 005	7 116	8 908	10 735	11 099	12 850	22 675	22 208	16 210	12 763	7 711	5 220
Capital expenditure as % of revenue	%	18%	16%	15%	12%	14%	15%	15%	15%	21%	21%	18%	31%	34%	29%	29%	25%	14%
Capital expenditure as % of operating costs	%	20%	20%	19%	16%	19%	27%	28%	28%	35%	39%	36%	58.0%	57.6%	57%	54%	40%	27%
Capital expenditure (real 2000 terms)	$ millions	3 534	2 509	2 204	2 582	3 548	5 129	5 910	7 125	8 617	8 765	9 837	17 007	16 416	11 791	9 273	5 532	3 668
Expansionary capital expenditure	$ millions	1 590	1 590	1 995	1 906	2 865	3 292	5 100	5 339	7 464	8 063	9 366	17 735	18 401	13 100	11 950	6 946	4 455
Stay-in business capital expenditure	$ millions	1 031	1 031	360	926	1 159	1 947	1 200	2 219	2 028	1 703	2 244	2 488	2 481	2 900	813	765	765
Stripping and development capital expenditure	$ millions	1 014	-	-	-	-	766	816	1 350	1 243	1 333	1 240	2 452	1 326	210	-	-	-
Net cash outflow from acquisition and disposals	$ millions	-1 505	-2 072	-405	-179	5 879	138	1 197	156	-693	-1 114	3 614	9 810	-3 482	-376	-1 261	-466	-1 059
Net acquistion and disposal cash flow plus expansionary capital	$ millions	85	-482	1 590	1 727	8 744	3 430	6 297	5 495	6 771	6 949	12 980	27 545	14 919	12 724	10 689	6 480	3 396
Net cash used in investing activities	**$ millions**	**1 116**	**549**	**1 950**	**2 653**	**9 903**	**6 143**	**8 313**	**9 064**	**10 042**	**9 985**	**16 464**	**32 485**	**18 726**	**15 834**	**11 502**	**7 245**	**4 161**
Net cash used in investing activities (real 2000 terms)	**$ millions**	**1 085**	**526**	**1 825**	**2 418**	**8 732**	**5 247**	**6 904**	**7 249**	**8 060**	**7 885**	**12 604**	**24 364**	**13 842**	**11 518**	**8 357**	**5 198**	**2 924**
Net capital allocated to investment activities as % of revenue	**%**	**5%**	**3%**	**12%**	**12%**	**33%**	**16%**	**18%**	**15%**	**20%**	**19%**	**23%**	**45%**	**28%**	**28%**	**26%**	**23%**	**11%**
Net capital allocated to investment activities as % of opex	**%**	**6%**	**4%**	**16%**	**15%**	**48%**	**28%**	**33%**	**28%**	**33%**	**35%**	**47%**	**83%**	**49%**	**56%**	**48%**	**37%**	**21%**
New capital commitments $ millions	$ millions	4 162	3 107	2 343	2 801	4 866	6 838	7 601	10 513	10 166	11 316	15 154	25 746	16 991	15 861	10 241	7 172	5 567
New capital commitments $ millions (real 2000 terms)	$ millions	4 047	2 974	2 193	2 553	4 290	5 841	6 313	8 408	8 160	8 936	11 601	19 310	12 560	11 537	7 440	5 146	3 912
Revenue	$ millions	20 698	15 896	15 608	22 887	29 587	39 099	47 473	59 473	50 211	52 798	71 739	72 226	65 968	56 762	44 636	30 912	38 285
Revenue (real 2000 terms)	$ millions	20 125	15 217	14 610	20 864	26 087	33 397	39 427	47 567	40 302	41 695	54 919	54 171	48 763	41 288	32 429	22 179	26 904
Operational costs	$ millions	17 893	12 992	12 375	17 657	20 697	21 910	25 433	32 274	30 330	28 447	35 404	39 099	38 553	28 463	23 828	19 432	19 416
Operational costs (real 2000 terms)	$ millions	17 398	12 437	11 584	16 096	18 249	18 715	21 122	25 813	24 345	22 465	27 103	29 325	28 498	20 704	17 312	13 942	13 644
Operational costs as % of revenue	%	86%	82%	79%	77%	70%	56%	54%	54%	60%	54%	49%	54%	58%	50%	53%	63%	51%
Total capital (Sum of shareholders equity, and net debt)	$ millions	20685	18980	18588	17 808	23 507	30 805	37 084	45 159	44 788	51 582	61 984	82 996	98177	104929	89185	80392	73579
Shareholders equity	$ millions	14 885	13 153	12 761	14 167	17 310	24 218	29 667	38 335	39 954	48 525	56 762	65 870	70 667	79 143	64 768	54 290	57 258
Shareholders equity (real 2000 terms)	$ millions	14 474	12 591	11 945	12 915	15 263	20 686	24 639	30 660	32 069	38 320	43 454	49 404	52 236	57 568	47 056	38 952	40 236
Net debt	$ millions	5800	5827	4 045	3 641	6 197	6 587	7 417	6 824	4 834	3 057	5 222	17 126	27510	25786	24417	26102	16321
Gearing ratio	%	39%	44%	31.70%	25.70%	35.80%	27.20%	25%	17.80%	12.10%	6.30%	9.20%	26%	39%	33%	38%	48%	29%
New capital commitments as % of total capital	%	0.20121	16.4%	12.6%	15.7%	20.7%	22.2%	20.5%	23.3%	22.7%	21.9%	24.4%	31.0%	17.3%	15.1%	11.5%	8.9%	7.6%
New capital commitments as % of turnover	%	20.1%	19.5%	15.0%	12.2%	16.4%	17.5%	16.0%	17.7%	20.2%	21.4%	21.1%	35.6%	25.8%	27.9%	22.9%	23.2%	14.5%
Capital expenditure as percentage of total capital	%	17.6%	13.8%	12.7%	15.9%	17.1%	19.5%	19.2%	19.7%	24.0%	21.5%	20.7%	27.3%	22.6%	15.4%	14.3%	9.6%	7.1%

Appendix 11.10: BHP economic data - part two

(Source: BHP, 2001 - 2017)

Description	**Units**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Profit before tax and special items	$ millions	1 313	2 607	2 783	8 337	8 940	14 166	18 011	23 483	11 617	19 572	31 255	23 022	17 872	14 955	4 390	-6 207	6 222
Impairment charges	$ millions	-199	-32	-73	-116	-16	-163	-305	-274	-190	-35	-74	-3 763	-5 496	-797	-4 024	-7 394	-193
Profit after tax	$ millions	770	1 695	1 900	6 601	6 628	10 543	13 496	15 962	6 338	13 009	23 946	15 532	11 075	13 832	1 910	-6 385	5 890
Net cash inflows from operating activities	$ millions	2 863	4 619	4 799	6 701	8 374	10 476	15 595	17 817	18 863	17 920	37 081	33274	27649	25 364	19 296	10 625	16 804
Net cash flows to net debt ratio	$ millions	49%	79%	119%	184%	135%	159%	210%	261%	390%	586%	710%	194%	101%	98%	79%	41%	103%
Net cash flows to revenue margin	%	14%	29%	31%	29%	28%	27%	33%	30%	38%	34%	52%	46%	42%	45%	43%	34%	44%
EBITDA	$ millions	2 805	4 726	4 983	6 652	11 089	17 098	21 127	28 031	22 275	24 513	37 093	33 746	28 109	30 292	21 852	12 340	20 296
EBITDA (real 2000 terms)	$ millions	2 727	4 524	4 664	6 064	9 777	14 605	17 546	22 419	17 879	19 358	28 396	25 310	20 778	22 034	15 876	8 854	14 262
Income taxes	$ millions	543	912	883	870	2 312	3 632	4 515	7 521	5 279	6 563	7 309	7 490	6 696	6 780	3 666	-1 052	4 100
NOPAT	$ millions	2 262	3 814	4 100	5 782	8 777	13 466	16 612	20 510	16 996	17 950	29 784	26 256	21 413	23 512	18 186	13 392	16 196
Sales	$ millions	20 698	15 896	15 608	22 887	29 587	39 099	47 473	59 473	50 211	52 798	71 739	72 226	65 968	56 762	44 636	30 912	38 285
NOPAT/ Sales	%	11%	24%	26%	25%	30%	34%	35%	34%	34%	34%	42%	36%	32%	41%	41%	43%	42%
Invested capital	$ millions	12 519	25 818	25 065	26 338	36 945	41 023	49 271	62 991	68 014	78 001	86 677	110 770	123 040	137 611	114 928	111 266	106 881
Dividends paid to shareholders	$ millions	472	831	868	1 576	1 642	1 936	2 271	3 135	4 969	4 895	5 144	6 220	7 004	6 639	6 498	4 130	2 921
Share buy-back	$ millions	-72	-121	20	0	1 792	2 028	5 741	3 115	0	0	9 860	83	0	0	0	0	0
Total dividends paid and share buy-backs	$ millions	400	710	888	1 576	3 434	3 964	8 012	6 250	4 969	4 895	15 004	6 303	7 004	6 639	6 498	4 130	2 921
Total distributions to shareholders as % of revenue	%	1.9%	4.5%	5.7%	6.9%	11.6%	10.1%	16.9%	10.5%	9.9%	9.3%	20.9%	8.7%	10.6%	11.7%	14.6%	13.4%	7.6%
Total distributions to shareholders as % of total assets	%	2.7%	2.4%	3.1%	5.3%	8.0%	7.7%	13.0%	8.2%	6.3%	5.5%	14.6%	4.9%	5.1%	4.4%	5.2%	3.5%	2.5%
Invested capital less cash	$ millions	11 916	24 319	23 513	24 696	35 723	40 247	47 334	58 754	57 181	65 545	76 593	105 889	116 990	128 808	108 175	100 947	92 728
Sales/ Invested capital		1.65	0.62	0.62	0.87	0.80	0.95	0.96	0.94	0.74	0.68	0.83	0.65	0.54	0.41	0.39	0.28	0.36
ROCE	%	**13.3%**	**12.3%**	**13.6%**	**21.7%**	**26.2%**	**36.0%**	**39.2%**	**40.8%**	**27.2%**	**26.0%**	**38.5%**	**25.4%**	**17.9%**	**16.6%**	**11%**	**3%**	**12%**
ROIC	%	**18.1%**	**14.8%**	**16.4%**	**22.0%**	**23.8%**	**32.8%**	**33.7%**	**32.6%**	**25.0%**	**23.0%**	**34.4%**	**23.7%**	**17.4%**	**17.1%**	**15.8%**	**12.0%**	**15.2%**
Capital allocated to investment as % of opex * commodity price index (CIPCI)		4%	2%	9%	10%	42%	27%	44%	44%	43%	44%	77%	127%	68%	74%	46%	25%	19%

Appendix 11.11: BHP ROIC and ROCE calculation

(Source: BHP, 2001 - 2017)

Description	Unit	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
ROIC Calculation																		
Net working capital	**$ millions**	**593**	**1 384**	**1 517**	**2 485**	**1 045**	**1 283**	**2 190**	**8 663**	**11 730**	**14 283**	**9 066**	**1 948**	**4 717**	**8 494**	**6 717**	**10 027**	**10 931**
Total current assets	$ millions	2 959	5 428	5 329	5 994	7 032	8 776	11 087	21 680	22 486	25 134	25 280	20 451	19 786	22 296	16 369	17 714	21 056
Non-interest bearing current liabilities	$ millions	-2 366	-4 044	-3 812	-3 509	-5 987	-7 493	-8 897	-13 017	-10 756	-10 851	-16 214	-18 503	-15 069	-13 802	-9 652	-7 687	-10 125
Current liabilities	$ millions	2 862	5 841	4 710	4 522	7 285	8 861	10 249	16 478	11 850	13 042	19 733	22 034	20 372	18 064	12 853	12 340	11 366
Interest bearing current liabilities	$ millions	496	1 797	898	1 013	1 298	1 368	1 352	3 461	1 094	2 191	3 519	3 531	5 303	4 262	3 201	4 653	1 241
Total non-current assets	$ millions	11 926	24 434	23 548	23 853	35 900	39 740	47 081	54 328	56 284	63 718	77 611	108 822	118 323	129 117	108 211	101 239	95 950
Invested capital	$ millions	12 519	25 818	25 065	26 338	36 945	41 023	49 271	62 991	68 014	78 001	86 677	110 770	123 040	137 611	114 928	111 266	106 881
Cash or cash equivalents	$ millions	603	1 499	1 552	1 642	1 222	776	1 937	4 237	10 833	12 456	10 084	4 881	6 050	8 803	6 753	10 319	14 153
Invested capital excluding cash	$ millions	11 916	24 319	23 513	24 696	35 723	40 247	47 334	58 754	57 181	65 545	76 593	105 889	116 990	128 808	108 175	100 947	92 728
Return on invested capital	%	18%	15%	16%	22%	24%	33%	34%	33%	25%	23%	34%	24%	17%	17%	16%	12%	15%
ROCE Calculation																		
EBIT	$ millions	1 595	2 957	3 294	5 488	9 330	15 277	20 067	24 282	18 214	19 719	31 980	27 238	21 127	22 098	11 866	3 469	12 389
Total assets	$ millions	14 885	29 862	28 877	29 847	42 932	51 343	61 404	76 008	78 770	88 852	102 891	129 201	138 109	151 413	124 580	118 953	117 006
Current liabilities	$ millions	2 862	5 841	4 710	4 522	7 285	8 861	10 249	16 478	11 850	13 042	19 733	22 034	20 372	18 064	12 853	12 340	11 366
Capital employed	$ millions	12 023	24 021	24 167	25 325	35 647	42 482	51 155	59 530	66 920	75 810	83 158	107 167	117 737	133 349	111 727	106 613	105 640
Return on capital employed	%	13%	12%	14%	22%	26%	36%	39%	41%	27%	26%	38%	25%	18%	17%	11%	3%	12%

Appendix 11.12: BHP production and commodity prices - part one

(Source: BHP, 2001 - 2017)

Description	Units	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Average
Rand/US$ Exchange Rate		8.62	10.48	7.55	6.44	6.37	6.77	7.05	8.27	8.41	7.32	7.26	8.21	9.65	10.85	12.78	14.7	13.31	**9.06**
Sterling/US$ Exchange Rate		0.69	0.67	0.61	0.55	0.55	0.54	0.5	0.54	0.64	0.65	0.62	0.63	0.64	0.61	0.65	0.74	0.78	**0.62**
Euro/US$ Exchange Rate		1.12	1.06	0.88	0.8	0.8	0.8	0.73	0.68	0.72	0.75	0.72	0.78	0.75	0.75	0.9	0.9	0.89	**0.83**
Australian Dollar/US$ Exchange Rate		1.93	1.84	1.53	1.36	1.31	1.33	1.19	1.17	1.26	1.09	0.97	0.97	1.03	1.11	1.33	1.34	1.3	**1.30**
Chilean Peso/US$ Exchange Rate				690	609	559	530	522	524	559	510	484	486	495	571	655	676	649	**567.93**
Brazilian real									1.84	2	1.76	1.67	1.95	2.16	2.35	3.34	3.48	3.19	**2.37**
US CPI Inflation		2.8%	1.6%	2.3%	2.7%	3.4%	3.2%	2.8%	3.8%	-0.4%	1.6%	3.2%	2.1%	1.5%	1.6%	0.1%	1.3%	2.1%	
US CPI Index		1.03	1.04	1.07	1.10	1.13	1.17	1.20	1.25	1.25	1.27	1.31	1.33	1.35	1.37	1.38	1.39	1.42	
Commodity Prices (Nominal)																			
Average market prices for the year																			
Petroleum	US$/BOE	29	23	28	32	47	62	64	97	70	75	93	95	109	109	74	43	50	**65**
Aluminium	US$/tonne	1 349	1 332	1 360	1 570	1 802	2 260	2 691	2 668	1 862	2 018	2 375	2 168	1 938	1 764	1 764	1 764	1 764	**1 909**
Alumina	US$/tonne	107	106	108	124	143	228	321	391	255	314	369	334	327	321	321	321	321	**259**
Copper	US$/tonne	1 433	1 499	1 609	2 513	3 148	5 027	7 077	7 782	4 916	6 702	8 642	8 179	7 672	7 011	6 371	4 894	5 291	**5 280**
Lead	US$/tonne	485	463	507	882	970	1 279	2 601	2 094	1 720	2 138	2 250	2 085	2 441	2 042	2 055	1 646	2 300	**1 645**
Zinc	US$/tonne	904	772	838	1 058	1 389	3 263	3 241	1 874	1 653	2 161	2 148	2 050	2 021	1 857	2 233	1 609	2 728	**1 870**
Gold	US$/oz	272	310	363	409	445	604	837	869	1 087	1 420	1 531	1 664	1 204	1 199	1 060	1 250	1 257	**928**
Silver	US$/oz	5	4	5	6	7	9	13	15	15	17	29	29	30	19	16	14	16	**15**
Uranium	US$/tonne	15 432	21 054	22 487	31 967	46 297	80 248	158 733	194 007	121 254	92 594	114 640	114 640	92 594	79 366	77 162	74 957	39 683	**81 007**
Molybdenum	US$/tonne	8 818	11 023	13 228	44 092	77 162	55 116	55 116	72 752	72 752	33 069	33 069	26 455	24 251	17 637	13 228	15 432	17 637	**34 755**
Diamonds	US$/carrat	923	405	342	312	267	378	300	289	278	417	605	700	700	700	700	700	700	**513**
Nickel	US$/tonne	7 145	5 930	7 628	12 103	14 947	15 498	37 809	28 440	13 294	19 357	23 942	19 335	16 380	15 168	15 476	9 348	10 141	**15 997**
Iron Ore	US$/tonne	29	28	30	23	38	46	50	142	90	119	163	151	127	123	72	51	70	**79**
Ferrochrome	US$/tonne	1 323	1 213	1 323	1 764	2 646	2 646	2 646	0	0	0	0	0	0	0	0	0	0	**1 937**
Manganese alloys	US$/tonne	796	769	823	631	1 050	1 250	1 926	2 208	1 854	1 328	1 319	1 260	1 143	1 020	1 020	1 020	1 020	**1 202**
Manganese ore	US$/tonne	155	150	161	123	205	244	376	431	405	278	270	211	224	213	213	213	213	**240**
Met Coal	US$/tonne	50	54	60	72	125	115	98	149	257	147	244	210	159	128	103	82	190	**132**
Energy Coal	US$/tonne	21	23	26	31	54	48	52	95	95	76	117	112	89	78	64	53	81	**65**

Appendix 11.13: BHP production and commodity prices data - part two

(Source: BHP, 2001 - 2017)

Description	Units	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Average
Commodity Prices (Real 2000 Prices)																			
Petroleum	US$/BOE	28	22	26	29	42	53	53	78	56	59	71	71	80	80	54	31	35	**51**
Aluminium	US$/tonne	1 312	1 275	1 273	1 431	1 589	1 930	2 235	2 134	1 495	1 594	1 818	1 626	1 433	1 283	1 282	1 266	1 240	**1 542**
Alumina	US$/tonne	104	101	101	113	126	195	266	313	205	248	282	251	242	233	233	230	226	**204**
Copper	US$/tonne	1 393	1 435	1 506	2 291	2 776	4 293	5 877	6 224	3 946	5 293	6 616	6 135	5 671	5 100	4 629	3 512	3 718	**4 142**
Lead	US$/tonne	472	443	475	804	855	1 092	2 161	1 675	1 380	1 689	1 722	1 564	1 804	1 485	1 493	1 181	1 616	**1 289**
Zinc	US$/tonne	879	739	784	965	1 225	2 787	2 692	1 499	1 327	1 706	1 644	1 538	1 494	1 351	1 622	1 154	1 917	**1 490**
Gold	US$/oz	264	297	340	373	392	516	695	695	872	1 121	1 172	1 248	890	872	770	897	883	**723**
Silver	US$/oz	5	4	4	5	6	7	11	12	12	14	22	22	22	14	12	10	11	**11**
Uranium	US$/tonne	15 005	20 155	21 050	29 141	40 821	68 545	131 829	155 167	97 326	73 122	87 762	85 982	68 445	57 730	56 060	53 780	27 886	**64 106**
Modymoleum	US$/tonne	8 574	10 552	12 382	40 194	68 035	47 078	45 774	58 188	58 395	26 115	25 316	19 842	17 926	12 829	9 610	11 072	12 394	**28 487**
Diamonds	US$/carrat	897	388	320	284	235	323	249	231	223	329	463	525	517	509	509	502	492	**412**
Nickel	US$/tonne	6 947	5 677	7 140	11 033	13 179	13 238	31 401	22 746	10 670	15 286	18 329	14 501	12 108	11 033	11 244	6 707	7 126	**12 845**
Iron Ore	US$/tonne	28	27	28	21	34	39	41	113	72	94	125	113	94	89	52	37	49	**62**
Ferrochrome	US$/tonne	1 286	1 161	1 238	1 608	2 333	2 260	2 197	0	0	0	0	0	0	0	0	0	0	**1 726**
Manganese alloys	US$/tonne	774	736	771	576	926	1 068	1 600	1 766	1 488	1 049	1 010	945	845	742	741	732	717	**970**
Manganese ore	US$/tonne	151	144	150	112	181	208	312	345	325	219	207	158	166	155	155	153	150	**194**
Met Coal	US$/tonne	49	52	56	65	110	98	81	119	206	116	187	158	118	93	75	59	134	**104**
Energy Coal	US$/tonne	21	22	24	28	47	41	43	76	76	60	89	84	66	57	47	38	57	**51**
Production Volumes																			
Petroleum	Million boe	105	134	122	123	119	117	116	130	138	159	159	222	236	246	256	240	208	**167**
Aluminium	tonnes (000)	984	992	1 074	1 256	1 330	1 362	1 340	1 298	1 233	1 241	1 246	1 153	1 179	1 174	843	0	0	**1 180**
Alumina	tonnes (000)	2 938	3 942	4 092	4 224	4 182	4 187	4 460	4 554	4 396	3 841	4 010	4 152	4 880	5 178	4 284	0	0	**4 221**
Copper	tonnes (000)	1 001	824	871	954	1 034	1 268	1 250	1 376	1 207	1 075	1 139	1 095	1 209	1 727	1 708	1 580	1 326	**1 214**
Lead	tonnes	206 200	236 100	240 000	249 900	282 000	266 300	210 800	253 100	230 100	248 400	244 600	239 900	214 400	188 000	153 700	3 700	5 500	**204 276**
Zinc	tonnes	121 700	162 500	193 900	159 200	105 300	109 100	118 700	144 500	163 200	198 300	152 200	112 200	128 200	109 900	126 400	55 400	87 500	**132 247**
Gold	troy oz	740	287 000	207 900	125 300	125 400	216 500	176 100	161 500	176 200	141 900	196 100	168 700	154 400	194 300	186 300	226 700	215 000	**174 120**
Silver	troy oz (000)	31 728	41 958	41 128	43 692	50 046	46 476	36 565	43 487	41 341	45 362	42 656	41 308	37 655	34 804	28 054	13 189	10 877	**37 078**
Uranium	tonnes	1 238	974	54	0	415	3 936	3 486	4 144	4 007	2 279	4 045	3 885	4 102	3 988	3 144	4 363	3 661	**2 983**
Molybdenum	tonnes	700	700	1 300	900	1 806	2 515	2 268	2 542	1 522	813	1 445	2 346	1 561	1 201	472	1 113	1 144	**1 432**
Diamonds	carats (000)	1 428	3 650	4 340	5 482	3 617	2 561	3 224	3 349	3 221	3 050	2 506	1 784	972	0	0	0	0	**3 014**
Nickel	tonnes (000)	61	69	78	82	92	175	186	168	173	176	153	158	154	143	124	81	85	**127**
Iron Ore	tonnes (000)	66 767	67 907	73 732	84 220	96 745	97 072	99 424	112 260	114 415	124 962	134 406	159 478	169 856	203 564	232 508	226 958	231 352	**135 037**
Ferrochrome	tonnes (000)	908	837	990	1 026	954	0	0	0	0	0	0	0	0	0	0	0	0	**943**
Manganese alloy	tonnes (000)	644	618	737	712	755	652	732	775	513	583	753	602	608	646	612	0	0	**663**
Manganese ore	tonnes (000)	3 774	3 535	4 102	4 953	5 455	5 280	6 009	6 575	4 475	6 124	7 093	7 931	8 517	8 302	7 224	0	0	**5 957**
Met Coal	tonnes (000)	31 957	35 532	34 622	35 360	37 303	35 643	38 429	35 193	36 416	37 381	32 678	33 230	37 650	45 078	49 837	42 840	39 899	**37 591**
Energy Coal	tonnes (000)	92 800	82 840	81 700	83 890	87 416	85 756	87 025	80 868	66 401	66 131	69 500	71 111	72 892	73 492	69 689	34 247	29 586	**72 667**

Appendix 11.14: BHP production and commodity prices - part three

(Source: BHP, 2001 - 2017)

Description	Units	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Average
Sales revenue - Nominal																			
Petroleum	$ million	3 088	3 030	3 427	3 949	5 606	7 265	7 421	12 608	9 698	11 914	14 870	21 112	25 617	26 906	18 897	10 372	10 337	**11 536**
Aluminium	$ million	1 327	1 321	1 461	1 972	2 397	3 078	3 606	3 463	2 296	2 504	2 959	2 500	2 285	2 071	1 487	0	0	**2 315**
Alumina	$ million	314	416	441	525	597	954	1 431	1 781	1 121	1 206	1 480	1 387	1 596	1 662	1 375	0	0	**1 086**
Copper	$ million	1 434	1 236	1 401	2 399	3 255	6 373	8 847	10 705	5 934	7 206	9 847	8 952	9 279	12 107	10 882	7 733	7 016	**6 741**
Lead	$ million	100	109	122	220	274	341	548	530	396	531	550	500	523	384	316	6	13	**321**
Zinc	$ million	110	125	162	168	146	356	385	271	270	428	327	230	259	204	282	89	239	**238**
Gold	$ million	0	89	75	51	56	131	147	140	192	201	300	281	186	233	197	283	270	**167**
Silver	$ million	148	180	191	246	344	398	467	638	632	790	1 250	1 200	1 118	668	446	181	176	**534**
Uranium	$ million	19	21	1	0	19	316	553	804	486	211	464	445	380	317	243	327	145	**297**
Molybdenum	$ million	6	8	17	40	139	139	125	185	111	27	48	62	38	21	6	17	20	**59**
Diamonds	$ million	1 318	1 480	1 485	1 710	966	967	968	969	896	1 272	1 517	1 249	680	0	0	0	0	**1 191**
Nickel	$ million	434	409	596	989	1 374	2 711	7 044	4 775	2 301	3 411	3 656	3 053	2 524	2 172	1 913	754	863	**2 293**
Iron Ore	$ million	1 936	1 901	2 212	1 937	3 702	4 421	4 957	15 914	10 278	14 822	21 905	24 108	21 611	24 977	16 650	11 659	16 079	**11 710**
Ferrochrome	$ million	1 201	1 015	1 310	1 810	2 524	0	0	0	0	0	0	0	0	0	0	0	0	**1 572**
Manganese alloys	$ million	513	475	607	450	793	815	1 410	1 711	951	774	993	759	695	659	624	0	0	**815**
Manganese ore	$ million	586	530	659	610	1 118	1 288	2 259	2 834	1 815	1 701	1 918	1 671	1 908	1 767	1 538	0	0	**1 480**
Met Coal	$ million	1 595	1 923	2 068	2 530	4 663	4 099	3 766	5 226	9 368	5 486	7 989	6 993	5 986	5 788	5 129	3 496	7 597	**4 924**
Energy Coal	$ million	1 982	1 919	2 089	2 569	4 677	4 082	4 482	7 650	6 319	5 021	8 111	7 961	6 495	5 760	4 486	1 829	2 382	**4 577**
Total		**16 112**	**16 188**	**18 325**	**22 175**	**32 650**	**37 732**	**48 416**	**70 203**	**53 062**	**57 507**	**78 185**	**82 462**	**81 180**	**85 697**	**64 471**	**36 747**	**45 136**	**49 779**
Pearson correlation coefficient - sales and price		**0.89**																	
Sales revenue - Real Terms 2000																			
Petroleum	$ million	3 003	2 901	3 208	3 600	4 943	6 205	6 163	10 084	7 784	9 409	11 384	15 834	18 936	19 571	13 729	7 441	7 264	**8 909**
Aluminium	$ million	1 291	1 265	1 367	1 798	2 113	2 629	2 995	2 770	1 843	1 978	2 265	1 875	1 689	1 506	1 080	0	0	**1 898**
Alumina	$ million	1 394	1 183	413	479	526	815	1 188	1 424	900	952	1 133	1 040	1 180	1 209	999	0	0	**989**
Copper	$ million	97	105	1 311	2 187	2 870	5 443	7 347	8 562	4 763	5 691	7 538	6 714	6 859	8 807	7 906	5 548	4 930	**5 099**
Lead	$ million	107	120	114	201	241	291	455	424	318	419	421	375	387	279	229	4	9	**259**
Zinc	$ million	0	85	152	154	129	304	319	217	217	338	250	173	192	148	205	64	168	**183**
Gold	$ million	143	172	71	47	49	112	122	112	154	159	230	211	137	169	143	203	190	**143**
Silver	$ million	19	20	179	224	303	340	387	510	507	624	957	900	826	486	324	130	123	**403**
Uranium	$ million	6	7	1	0	17	270	460	643	390	167	355	334	281	230	176	235	102	**230**
Molybdenum	$ million	6	7	16	36	123	118	104	148	89	21	37	47	28	15	5	12	14	**49**
Diamonds	$ million	422	391	1 390	1 559	852	826	804	775	719	1 005	1 161	937	503	0	0	0	0	**873**
Nickel	$ million	1 883	1 820	558	901	1 211	2 315	5 850	3 819	1 847	2 693	2 799	2 290	1 866	1 580	1 390	541	606	**1 998**
Iron Ore	$ million	1 168	972	2 071	1 766	3 264	3 776	4 117	12 728	8 250	11 705	16 770	18 082	15 975	18 168	12 097	8 365	11 299	**8 857**
Ferrochrome	$ million	498	455	1 226	1 650	2 225	0	0	0	0	0	0	0	0	0	0	0	0	**1 211**
Manganese alloys	$ million	1 551	1 841	568	410	699	696	1 171	1 369	763	611	760	569	514	479	454	0	0	**830**
Manganese ore	$ million	1 551	1 841	617	556	986	1 100	1 876	2 267	1 456	1 343	1 469	1 253	1 410	1 285	1 117	0	0	**1 342**
Met Coal	$ million	1 551	1 841	1 936	2 306	4 111	3 501	3 128	4 180	7 519	4 332	6 116	5 245	4 425	4 210	3 726	2 508	5 338	**3 881**
Energy Coal	$ million	1 927	1 837	1 955	2 342	4 124	3 487	3 722	6 119	5 072	3 965	6 209	5 971	4 801	4 190	3 259	1 313	1 674	**3 645**
Total		**16 616**	**16 863**	**17 154**	**20 215**	**28 788**	**32 229**	**40 210**	**56 148**	**42 591**	**45 413**	**59 854**	**61 848**	**60 007**	**62 335**	**46 840**	**26 365**	**31 718**	**39 129**
Pearson correlation coefficient - sales and price		**0.93**																	

Appendix 11.15: BHP basket price index calculation - part one

(Source: BHP, 2001 - 2017)

Description	Units	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Commodity % Contribution to Total Sales																		
Petroleum	%	19%	19%	19%	18%	17%	19%	15%	18%	18%	21%	19%	26%	32%	31%	29%	28%	23%
Aluminium	%	8%	8%	8%	9%	7%	8%	7%	5%	4%	4%	4%	3%	3%	2%	2%	0%	0%
Alumina	%	2%	3%	2%	2%	2%	3%	3%	3%	2%	2%	2%	2%	2%	2%	2%	0%	0%
Copper	%	9%	8%	8%	11%	10%	17%	18%	15%	11%	13%	13%	11%	11%	14%	17%	21%	16%
Lead	%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	0%	0%	0%	0%
Zinc	%	1%	1%	1%	1%	0%	1%	1%	0%	1%	1%	0%	0%	0%	0%	0%	0%	1%
Gold	%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%
Silver	%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	1%	1%	1%	1%	0%	0%
Uranium	%	0%	0%	0%	0%	0%	1%	1%	1%	1%	0%	1%	1%	0%	0%	0%	1%	0%
Molybdenum	%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Diamonds	%	8%	9%	8%	8%	3%	3%	2%	1%	2%	2%	2%	2%	1%	0%	0%	0%	0%
Nickel	%	3%	3%	3%	4%	4%	7%	15%	7%	4%	6%	5%	4%	3%	3%	3%	2%	2%
Iron Ore	%	12%	12%	12%	9%	11%	12%	10%	23%	19%	26%	28%	29%	27%	29%	26%	32%	36%
Ferrochrome	%	7%	6%	7%	8%	8%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Manganese alloys	%	3%	3%	3%	2%	2%	2%	3%	2%	2%	1%	1%	1%	1%	1%	1%	0%	0%
Manganese ore	%	4%	3%	4%	3%	3%	3%	5%	4%	3%	3%	2%	2%	2%	2%	2%	0%	0%
Met Coal	%	10%	12%	11%	11%	14%	11%	8%	7%	18%	10%	10%	8%	7%	7%	8%	10%	17%
Energy Coal	%	12%	12%	11%	12%	14%	11%	9%	11%	12%	9%	10%	10%	8%	7%	7%	5%	5%
Commodity Price Index (Real Terms)																		
Petroleum	%	56%	42%	52%	58%	81%	103%	104%	152%	110%	116%	140%	139%	157%	156%	105%	61%	68%
Aluminium	%	85%	83%	83%	93%	103%	125%	145%	138%	97%	103%	118%	105%	93%	83%	83%	82%	80%
Alumina	%	51%	49%	49%	56%	62%	95%	131%	153%	100%	122%	138%	123%	118%	114%	114%	113%	111%
Copper	%	34%	35%	36%	55%	67%	104%	142%	150%	95%	128%	160%	148%	137%	123%	112%	85%	90%
Lead	%	37%	34%	37%	62%	66%	85%	168%	130%	107%	131%	134%	121%	140%	115%	116%	92%	125%
Zinc	%	59%	50%	53%	65%	82%	187%	181%	101%	89%	115%	110%	103%	100%	91%	109%	78%	129%
Gold	%	37%	41%	47%	52%	54%	71%	96%	96%	121%	155%	162%	173%	123%	121%	106%	124%	122%
Silver	%	40%	36%	38%	45%	53%	65%	93%	103%	108%	121%	198%	192%	194%	123%	102%	87%	100%
Uranium	%	23%	31%	33%	45%	64%	107%	206%	242%	152%	114%	137%	134%	107%	90%	87%	84%	43%
Molybdenum	%	30%	37%	43%	141%	239%	165%	161%	204%	205%	92%	89%	70%	63%	45%	34%	39%	44%
Diamonds	%	218%	94%	78%	69%	57%	78%	61%	56%	54%	80%	113%	128%	126%	124%	124%	122%	119%
Nickel	%	54%	44%	56%	86%	103%	103%	244%	177%	83%	119%	143%	113%	94%	86%	88%	52%	55%
Iron Ore	%	45%	43%	45%	34%	54%	63%	67%	182%	116%	151%	201%	182%	151%	144%	84%	59%	79%
Ferrochrome	%	75%	67%	72%	93%	135%	131%	127%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Manganese alloys	%	80%	76%	79%	59%	96%	110%	165%	182%	153%	108%	104%	97%	87%	77%	76%	75%	74%
Manganese ore	%	78%	74%	78%	58%	93%	108%	161%	178%	168%	113%	107%	82%	86%	80%	80%	79%	77%
Met Coal	%	46%	50%	54%	62%	106%	94%	78%	114%	198%	111%	179%	151%	113%	89%	72%	56%	128%
Energy Coal	%	40%	43%	46%	54%	92%	79%	83%	147%	148%	116%	174%	163%	128%	111%	91%	74%	110%

Appendix 11.16: BHP basket price index calculation - part two

(Source: BHP, 2001 - 2017)

Description	Units	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Commodity Price Index Weighted by Sales Volumes																		
Petroleum	%	0.11	0.08	0.10	0.10	0.14	0.20	0.16	0.27	0.20	0.24	0.27	0.36	0.50	0.49	0.31	0.17	0.16
Aluminium	%	0.07	0.07	0.07	0.08	0.08	0.10	0.11	0.07	0.04	0.05	0.04	0.03	0.03	0.02	0.02	-	-
Alumina	%	0.01	0.01	0.01	0.01	0.01	0.02	0.04	0.04	0.02	0.03	0.03	0.02	0.02	0.02	0.02	-	-
Copper	%	0.03	0.03	0.03	0.06	0.07	0.18	0.26	0.23	0.11	0.16	0.20	0.16	0.16	0.17	0.19	0.18	0.14
Lead	%	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00
Zinc	%	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Gold	%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.01
Silver	%	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.03	0.03	0.03	0.01	0.01	0.00	0.00
Uranium	%	0.00	0.00	0.00	-	0.00	0.01	0.02	0.03	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.01	0.00
Molybdenum	%	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Diamonds	%	0.18	0.09	0.06	0.05	0.02	0.02	0.01	0.01	0.01	0.02	0.02	0.02	0.01	-	-	-	-
Nickel	%	0.01	0.01	0.02	0.04	0.04	0.07	0.36	0.12	0.04	0.07	0.07	0.04	0.03	0.02	0.03	0.01	0.01
Iron Ore	%	0.05	0.05	0.05	0.03	0.06	0.07	0.07	0.41	0.22	0.39	0.56	0.53	0.40	0.42	0.22	0.19	0.28
Ferrochrome	%	0.06	0.04	0.05	0.08	0.10	-	-	-	-	-	-	-	-	-	-	-	-
Manganese alloys	%	0.03	0.02	0.03	0.01	0.02	0.02	0.05	0.04	0.03	0.01	0.01	0.01	0.01	0.01	0.01	-	-
Manganese ore	%	0.03	0.02	0.03	0.02	0.03	0.04	0.08	0.07	0.06	0.03	0.03	0.02	0.02	0.02	0.02	-	-
Met Coal	%	0.05	0.06	0.06	0.07	0.15	0.10	0.06	0.08	0.35	0.11	0.18	0.13	0.08	0.06	0.06	0.05	0.22
Energy Coal	%	0.05	0.05	0.05	0.06	0.13	0.09	0.08	0.16	0.18	0.10	0.18	0.16	0.10	0.07	0.06	0.04	0.06
Basket price index weighted by sales		**0.68**	**0.55**	**0.57**	**0.64**	**0.88**	**0.97**	**1.33**	**1.57**	**1.30**	**1.25**	**1.65**	**1.53**	**1.40**	**1.33**	**0.95**	**0.66**	**0.88**

Appendix 11.17: Rio Tinto economic data - part one

(Source: Rio Tinto, 2001 - 2017)

Description	**Units**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
US$ inflation index		1.03	1.04	1.07	1.10	1.13	1.17	1.20	1.25	1.25	1.27	1.31	1.33	1.35	1.37	1.38	1.39	1.42
Year-end open capital commitments $ millions	$ millions	624	652	679	700	1 322	2 413	3 978	4 354	3 875	7 573	13 041	12 898	7 246	3 100	1 191	2 343	2 670
Capital expenditure	$ millions	1 407	1 417	1 611	2 218	2 554	3 988	4 968	8 488	5 356	4 553	12 573	17 615	13 001	8 162	4 685	3 012	4 482
Capital expenditure (real 2000 terms)	$ millions	1 368	1 357	1 508	2 022	2 252	3 406	4 126	6 789	4 299	3 596	9 625	13 212	9 610	5 937	3 404	2 161	3 150
Capital expenditure as % of revenue	%	13%	13%	13%	15%	12%	16%	15%	15%	12%	8%	21%	35%	25%	17%	13%	9%	11%
Capital expenditure as % of operational costs	%	21%	19%	21%	23%	21%	29%	24%	23%	17%	13%	35%	47%	36%	24%	17%	11%	17%
Net cash outflow from acquisition	$ millions	958	106	-	3	2	303	37 539	9	396	907	4 156	1 335	-4	-	3	-	-
Net cash outflow from acquisition as % of revenue	$ millions	9%	1%	0%	0%	0%	1%	112%	0%	1%	2%	7%	3%	0%	0%	0%	0%	0%
Net cash inflow from disposals	$ millions	299	233	405	1 510	323	24	13	2 572	2 424	604	386	251	1 896	887	-38	761	2 675
Net cash from acquisitions plus disposals	$ millions	659	-127	-405	-1 507	-321	279	37 526	-2 563	-2 028	303	3 770	1 084	-1 900	-887	41	-761	-2 675
Net acquistion and disposal cash flow plus capital	$ millions	2 066	1 290	1 206	711	2 233	4 267	42 494	5 925	3 328	4 856	16 343	18 699	11 101	7 275	4 726	2 251	1 807
Net cash used in investing activities	**$ millions**	**2 066**	**1 290**	**1 206**	**711**	**2 233**	**4 267**	**42 494**	**5 925**	**3 328**	**4 856**	**16 343**	**18 699**	**11 101**	**7 275**	**4 726**	**2 251**	**1 807**
Net cash used in investing activities as % of revenue	**%**	20%	12%	10%	5%	11%	17%	127%	10%	8%	8%	27%	37%	22%	15%	14%	7%	5%
Net cash used in investing activities as % of opex	**%**	31%	17%	16%	7%	18%	31%	205%	16%	10%	14%	45%	50%	31%	21%	17%	8%	7%
Net cash used in investing activities (real 2000 terms)	**$ millions**	**2 009**	**1 235**	**1 129**	**648**	**1 969**	**3 645**	**35 292**	**4 739**	**2 671**	**3 835**	**12 511**	**14 025**	**8 206**	**5 292**	**3 434**	**1 615**	**1 270**
New capital commitments $ millions	$ millions	1 407	1 445	1 639	2 239	3 176	5 079	6 533	8 864	4 877	8 251	18 041	17 472	7 349	4 016	2 776	4 164	4 809
New capital commitments $ millions (real 2000 terms)	$ millions	1 368	1 383	1 534	2 041	2 800	4 338	5 426	7 089	3 915	6 516	13 811	13 104	5 432	2 921	2 017	2 988	3 379
Revenue	$ millions	10 438	11 119	12 119	14 530	20 742	25 440	33 518	58 065	44 036	60 323	60 529	50 942	51 171	47 664	34 829	33 781	40 030
Revenue (real 2000 terms)	$ millions	10 149	10 644	11 344	13 245	18 289	21 730	27 837	46 441	35 346	47 637	46 337	38 207	37 825	34 670	25 304	24 237	28 130
Operational costs	$ millions	6 590	7 612	7 732	9 622	12 436	13 892	20 752	37 641	32 255	35 262	36 260	37 534	36 104	33 910	27 919	26 799	26 983
Operational costs (real 2000 terms)	$ millions	6 408	7 287	7 238	8 771	10 965	11 866	17 235	30 105	25 890	27 847	27 759	28 151	26 688	24 666	20 284	19 228	18 961
Operational costs as % of revenue	%	63%	68%	64%	66%	60%	55%	62%	65%	73%	58%	60%	74%	71%	71%	80%	79%	67%
Total capital (Sum of shareholders equity, and net debt)	$ millions	12754	13209	15683	15686	16261	20669	69963	59310	62692	62318	60541	65745	63941	58780	51132	48877	48556
Shareholder equity	$ millions	7176	7462	10037	11877	14948	18232	24772	20638	43831	58247	52199	46553	45886	46285	37349	39290	44711
Shareholder equity (real 2000 terms)	$ millions	6977	7143	9395	10827	13180	15573	20573	16506	35181	45998	39960	34916	33919	33667	27135	28190	31419
Net debt	$ millions	5578	5747	5646	3809	1313	2437	45191	38672	18861	4071	8342	19192	18 055	12 495	13 783	9587	3845
Gearing ratio	%	78%	77%	56%	32%	9%	13%	182%	187%	43%	7%	16%	41%	39%	27%	37%	24%	9%
New capital commitments as % of total capital	%	11.0%	10.9%	10.4%	14.3%	19.5%	24.6%	9.3%	14.9%	7.8%	13.2%	29.8%	26.6%	11.5%	6.8%	5.4%	8.5%	9.9%
New capital commitments as % of turnover	%	13.5%	13.0%	13.5%	15.4%	15.3%	20.0%	19.5%	15.3%	11.1%	13.7%	29.8%	34.3%	14.4%	8.4%	8.0%	12.3%	12.0%
Capital expenditure as percentage of total capital	%	11.0%	10.7%	10.3%	14.1%	15.7%	19.3%	7.1%	14.3%	8.5%	7.3%	20.8%	26.8%	20.3%	13.9%	9.2%	6.2%	9.2%

Appendix 11.18: Rio Tinto economic data - part two

(Source: Rio Tinto, 2001 - 2017)

Description	Units	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Profit before tax and special items	$ millions	1 983	1 311	2 094	3 863	7 312	10 240	9 836	9 178	7 860	20 491	13 272	-2 431	3 505	9 552	-726	6 343	12 816
Profit after tax	$ millions	1 079	651	1 508	3 297	5 251	7 438	7 312	3 676	4 872	14 238	5 835	-3 028	3 665	6 527	-866	4 617	8 762
Net cash inflows from operating activities	$ millions	3 285	3 619	3 359	4 265	8 031	10 923	12 569	20 668	13 834	23 530	20 235	9430	15078	14 286	9 383	8 465	13 884
Net cash inflows from operating activities as % of	%	31%	33%	28%	29%	39%	43%	37%	36%	31%	39%	33%	19%	29%	30%	27%	25%	35%
Net cash flows to net debt ratio	$ millions	59%	63%	59%	112%	612%	448%	28%	53%	73%	578%	243%	49%	84%	114%	68%	88%	361%
Net total cash in-flows from operating activities and	%	34%	35%	31%	40%	40%	43%	38%	40%	37%	40%	34%	19%	33%	32%	27%	27%	41%
Impairment charges	$ millions	-715	-978	-	-558	3	396	-58	-8 015	-1 573	-982	-9 174	-14 701	-7 315	-1 062	-2 791	-249	-796
EBITDA	$ millions	4 031	4 227	3 998	5 370	9 332	12 524	13 920	22 317	14 312	25 798	28 925	19 595	20 953	18 840	12 058	12 823	20 492
EBITDA (real 2000 terms)	$ millions	3 919	4 047	3 742	4 895	8 228	10 698	11 561	17 849	11 488	20 373	22 143	14 697	15 488	13 704	8 761	9 200	14 400
Income taxes	$ millions	462	615	567	841	1 814	2 373	2 090	3 742	2 076	5 296	6 439	589	2 426	3 053	993	1 567	3 965
NOPAT	$ millions	3 569	3 612	3 431	4 529	7 518	10 151	11 830	18 575	12 236	20 502	22 486	19 006	18 527	15 787	11 065	11 256	16 527
Sales	$ millions	10 438	11 119	12 119	14 530	20 742	25 440	33 518	58 065	44 036	60 323	60 529	50 942	51 171	47 664	34 829	33 781	40 030
NOPAT/ Sales		34%	32%	28%	31%	36%	40%	35%	32%	28%	34%	37%	37%	36%	33%	32%	33%	41%
Dividends paid to shareholders	$ millions	812	826	882	1 062	1 143	2 573	1 507	1 952	981	1 765	2 250	3 023	3 288	3 780	4 133	2 741	4 199
Share buy-backs	$ millions	0	0	0	0	0	2 607	1 843	295	92	228	5 820	1 752	309	372	2 234	189	2 276
Total dividends paid and share buy-back	$ millions	812	826	882	1 062	1 143	5 180	3 350	2 247	1 073	1 993	8 070	4 775	3 597	4 152	6 367	2 929	6 474
Total distributions to shareholders as % of revenue	%	7.8%	7.4%	7.3%	7.3%	5.5%	20.4%	10.0%	3.9%	2.4%	3.3%	13.3%	9.4%	7.0%	8.7%	18.3%	8.7%	16.2%
Total distributions to shareholders as % of total assets	%	4.1%	4.1%	3.7%	4.1%	3.8%	15.0%	3.3%	2.5%	1.2%	1.8%	6.7%	4.1%	3.3%	3.9%	7.0%	3.3%	6.8%
Invested capital	$ millions	17 541	18 230	21 941	23 122	26 219	30 218	89 753	77 550	83 772	99 965	106 317	105 685	98 809	97 979	83 709	80 792	84 911
Invested capital less cash	$ millions	16 862	17 905	21 546	22 732	23 840	29 482	88 108	76 369	79 539	90 017	96 591	98 550	88 593	85 556	74 343	72 591	74 361
Sales/ Invested capital	%	60%	61%	55%	63%	79%	84%	37%	75%	53%	60%	57%	48%	52%	49%	42%	42%	47%
ROCE	%	22.6%	18.1%	11.5%	14.4%	29.2%	34.5%	12.9%	26.2%	11.9%	21.4%	22.6%	13.0%	16.9%	14.5%	9%	10%	16%
ROIC	%	20.3%	19.8%	15.6%	19.6%	28.7%	33.6%	13.2%	24.0%	14.6%	20.5%	21.1%	18.0%	18.8%	16.1%	13.2%	13.9%	19.5%
Capital allocated to investment as % of opex * commodity price index (CIPCI)		18%	8%	8%	5%	15%	30%	230%	21%	10%	20%	82%	74%	44%	26%	15%	7%	6%

Appendix 11.19: Rio Tinto ROIC and ROCE calculation

(Source: Rio Tinto, 2001 - 2017)

Description	Unit	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
ROIC Calculation																		
Net working capital	**$ millions**	**2 586**	**2 398**	**2 751**	**2 464**	**3 897**	**2 599**	**10 593**	**6 369**	**6 250**	**10 728**	**8 489**	**7 758**	**10 066**	**11 277**	**7 699**	**6 615**	**8 357**
Total current assets	$ millions	4 661	4 372	4 891	5 053	7 481	6 875	21 931	18 435	14 932	21 459	22 236	19 540	21 330	20 813	15 261	15 055	18 678
Non-interest bearing current liabilities	$ millions	-2 075	-1 974	-2 140	-2 589	-3 584	-4 276	-11 338	-12 066	-8 682	-10 731	-13 747	-11 782	-11 264	-9 536	-7 562	-8 440	-10 321
Current liabilities	$ millions	5 910	5 340	4 334	3 395	4 786	5 780	19 551	22 100	9 529	11 795	15 162	13 980	15 190	12 220	10 046	9 362	11 225
Interest bearing current liabilities	$ millions	3 835	3 366	2 194	806	1 202	1 504	8 213	10 034	847	1 064	1 415	2 198	3 926	2 684	2 484	922	904
Total non-current assets	$ millions	14 955	15 832	19 190	20 658	22 322	27 619	79 160	71 181	77 522	89 237	97 828	97 927	88 743	86 702	76 010	74 177	76 554
Invested capital	$ millions	17 541	18 230	21 941	23 122	26 219	30 218	89 753	77 550	83 772	99 965	106 317	105 685	98 809	97 979	83 709	80 792	84 911
Cash or cash equivalents	$ millions	679	325	395	390	2 379	736	1 645	1 181	4 233	9 948	9 726	7 135	10 216	12 423	9 366	8 201	10 550
Invested capital excluding cash	$ millions	16 862	17 905	21 546	22 732	23 840	29 482	88 108	76 369	79 539	90 017	96 591	98 550	88 593	85 556	74 343	72 591	74 361
Return on invested capital (ROIC)	%	20%	20%	16%	20%	29%	34%	13%	24%	15%	21%	21%	18%	19%	16%	13%	14%	19%
ROCE Calculation																		
EBIT	$ millions	3 102	2 696	2 266	3 224	7 301	9 912	10 517	17 683	9 843	21 128	23 662	13 467	16 039	13 851	7 310	8 053	13 363
EBITDA	$ millions	4 031	4 227	3 998	5 370	9 332	12 524	13 920	22 317	14 312	25 798	28 925	19 595	20 953	18 840	12 058	12 823	20 492
less depreciation and amortisiation	$ millions	-929	-954	-1 006	-1 204	-1 334	-1 469	-2 115	-3 475	-3 427	-3 437	-3 972	-4 624	-4 791	-4 860	-4 645	-4 794	-4 375
Total assets	$ millions	19 616	20 204	24 081	25 711	29 803	34 494	101 091	89 616	92 454	110 696	120 064	117 467	110 073	107 515	91 271	89 232	95 232
Current liabilities	$ millions	5 910	5 340	4 334	3 395	4 786	5 780	19 551	22 100	9 529	11 795	15 162	13 980	15 190	12 220	10 046	9 362	11 225
Capital employed	$ millions	13 706	14 864	19 747	22 316	25 017	28 714	81 540	67 516	82 925	98 901	104 902	103 487	94 883	95 295	81 225	79 870	84 007
Return on capital employed (ROCE)	%	23%	18%	11%	14%	29%	35%	13%	26%	12%	21%	23%	13%	17%	15%	9%	10%	16%

Appendix 11.20: Rio Tinto production and commodity prices - part one

(Source: Rio Tinto, 2001 - 2017)

Description	Units	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Average
Rand/US$ Exchange Rate		8.62	10.48	7.55	6.44	6.37	6.77	7.05	8.27	8.41	7.32	7.26	8.21	9.65	10.85	12.78	14.7	13.31	**9.06**
Sterling/US$ Exchange Rate		0.69	0.67	0.61	0.55	0.55	0.54	0.5	0.54	0.64	0.65	0.62	0.63	0.64	0.61	0.65	0.74	0.78	**0.62**
Euro/US$ Exchange Rate		1.12	1.06	0.88	0.8	0.8	0.8	0.73	0.68	0.72	0.75	0.72	0.78	0.75	0.75	0.9	0.9	0.89	**0.83**
Australian Dollar/US$ Exchange Rate		1.93	1.84	1.53	1.36	1.31	1.33	1.19	1.17	1.26	1.09	0.97	0.97	1.03	1.11	1.33	1.34	1.3	**1.30**
Chilean Peso/US$ Exchange Rate				690	609	559	530	522	524	559	510	484	486	495	571	655	676	649	**568**
Brazilian real									1.84	2	1.76	1.67	1.95	2.16	2.35	3.34	3.48	3.19	**2.37**
US CPI Inflation		2.8%	1.6%	2.3%	2.7%	3.4%	3.2%	2.8%	3.8%	-0.4%	1.6%	3.2%	2.1%	1.5%	1.6%	0.1%	1.3%	2.1%	
US CPI Index		1.03	1.04	1.07	1.10	1.13	1.17	1.20	1.25	1.25	1.27	1.31	1.33	1.35	1.37	1.38	1.39	1.42	
Commodity Prices (Nominal)																			
Average market prices for the year																			
Alumina	US$/tonne	208	205	210	242	278	348	415	401	287	311	366	326	297	289	275	259	327	**297**
Aluminium	US$/tonne	1 349	1 332	1 360	1 570	1 802	2 260	2 691	2 601	1 862	2 018	2 375	2 168	1 938	1 764	1 764	1 764	1 764	**1 905**
Bauxite	US$/tonne	32	32	32	37	43	54	64	62	44	48	56	43	47	47	47	40	40	**45**
Borates	US$/tonne	361	356	406	652	838	1 530	1 723	1 739	2 080	2 030	1 788	1 417	1 327	1 329	1 311	1 233	1 219	**1 255**
Coking coal	US$/tonne	32	34	33	37	50	53	45	67	66	106	294	224	177	148	119	112	181	**105**
Thermal coal	US$/tonne	14	15	14	16	21	22	24	43	25	55	140	119	99	90	74	73	77	**54**
Copper	US$/tonne	1 587	1 565	1 786	2 866	3 682	6 724	7 121	7 055	5 159	7 540	8 818	7 959	7 319	6 856	5 490	4 872	6 173	**5 445**
Diamonds	US$/carrat	31	11	17	30	30	24	39	40	32	49	62	56	53	65	40	34	33	**38**
Gold	US$/oz	272	310	363	409	445	603	695	872	972	1 125	1 572	1 669	1 411	1 266	1 160	1 250	1 257	**921**
Iron Ore	US$/tonne	19	19	21	24	44	52	61	104	70	127	153	122	124	100	56	58	71	**72**
Lead	US$/tonne	560	540	530	950	921	1 173	2 725	1 871	-	-	-	-	-	-	-	-	-	**1 159**
Molybdenum	US$/tonne	8 818	11 023	13 228	44 092	77 162	55 116	55 116	68 343	72 752	33 069	33 069	26 455	24 251	17 637	13 228	15 432	17 637	**34 496**
Nickel	US$/tonne	5 886	6 768	9 634	13 845	14 727	24 141	37 170	21 010	14 705	21 804	22 818	17 505	14 991	16 865	11 817	9 612	10 406	**16 100**
Salt	US$/tonne	14	14	16	26	33	60	51	61	77	85	66	61	60	59	55	50	42	**49**
Silver	US$/oz	4	4	5	6	7	9	13	15	15	17	29	29	30	19	16	14	16	**15**
Tin	US$/tonne	4 428	3 964	4 950	8 833	-	-	-	-	-	-	-	-	-	-	-	-	-	**5 544**
Titanium dioxide slag	US$/tonne	250	259	280	324	591	699	1 147	1 259	1 119	956	1 095	1 400	1 388	1 502	1 443	1 354	1 341	**965**
Uranium	US$/lb	44	45	42	50	56	37	63	68	70	90	159	36	38	54	35	34	18	**55**
Zinc	US$/tonne	903	821	803	1 058	1 238	3 394	3 373	1 904	-	-	-	-	-	-	-	-	-	**1 687**

Appendix 11.21: Rio Tinto production and commodity prices - part two

(Source: Rio Tinto, 2001 - 2017)

Description	Units	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Average
Commodity Prices (Real 2000 Prices)																			
Alumina	US$/tonne	202	197	196	221	245	297	344	321	230	246	280	245	220	210	200	185	230	**239**
Aluminium	US$/tonne	1 312	1 275	1 273	1 431	1 589	1 930	2 235	2 081	1 495	1 594	1 818	1 626	1 433	1 283	1 282	1 266	1 240	**1 539**
Bauxite	US$/tonne	31	30	30	34	38	46	53	49	35	38	43	33	34	34	34	29	28	**36**
Borates	US$/tonne	351	341	380	594	739	1 307	1 431	1 391	1 670	1 603	1 369	1 063	981	967	952	884	856	**993**
Coking coal	US$/tonne	32	33	31	34	44	45	38	53	53	84	225	168	131	108	86	80	127	**81**
Thermal coal	US$/tonne	13	14	13	14	19	19	20	34	20	43	107	89	73	66	54	53	54	**41**
Copper	US$/tonne	1 543	1 498	1 672	2 613	3 246	5 743	5 914	5 642	4 141	5 954	6 751	5 969	5 410	4 987	3 988	3 496	4 338	**4 289**
Diamonds	US$/carrat	30	11	16	27	27	20	33	32	26	39	47	42	39	47	29	24	23	**30**
Gold	US$/oz	264	297	340	373	392	515	577	697	780	888	1 203	1 252	1 043	921	843	897	883	**716**
Iron Ore	US$/tonne	18	18	20	22	39	45	50	83	56	101	117	92	92	73	41	42	50	**56**
Lead	US$/tonne	545	517	496	866	812	1 002	2 263	1 496	-	-	-	-	-	-	-	-	-	**1 000**
Molybdenum	US$/tonne	8 574	10 552	12 382	40 194	68 035	47 078	45 774	54 661	58 395	26 115	25 316	19 842	17 926	12 829	9 610	11 072	12 394	**28 279**
Nickel	US$/tonne	5 723	6 479	9 018	12 621	12 985	20 620	30 870	16 804	11 803	17 218	17 468	13 129	11 082	12 268	8 585	6 896	7 312	**12 993**
Salt	US$/tonne	14	13	15	23	29	52	43	49	62	67	50	46	44	43	40	36	30	**39**
Silver	US$/oz	4	4	4	5	6	7	11	12	12	14	22	22	22	14	12	10	11	**11**
Tin	US$/tonnes	4 305	3 795	4 634	8 052	-	-	-	-	-	-	-	-	-	-	-	-	-	**5 196**
Titanium dioxide slag	US$/tonne	243	248	262	295	521	597	953	1 007	899	755	838	1 050	1 026	1 093	1 048	971	942	**750**
Uranium	US$/lb	243	248	262	295	521	597	953	1 007	899	755	838	1 050	1 026	1 093	1 048	971	942	**750**
Zinc	US$/tonne	878	786	752	964	1 092	2 899	2 801	1 523	-	-	-	-	-	-	-	-	-	**1 462**
Production Volumes																			
Alumina	tonnes (000)	1 761	1 947	2 014	2 231	2 963	3 247	3 877	9 009	5 929	6 109	5 846	6 968	7 037	7 458	7 788	8 192	8 131	**5 324**
Aluminium	tonnes (000)	766	794	817	837	854	840	1 473	4 062	3 808	3 790	3 824	3 456	3 555	3 361	3 322	3 646	3 551	**2 515**
Bauxite	tonnes (000)	11 795	11 724	12 316	12 828	15 474	16 319	20 900	34 987	30 325	33 082	35 437	39 363	43 204	41 871	43 677	47 703	50 796	**29 518**
Borates	tonnes (000)	564	528	559	565	560	553	560	610	424	500	504	463	495	508	476	503	517	**523**
Coking coal	tonnes (000)	1 962	1 925	2 311	6 760	7 195	5 909	6 179	7 431	10 352	12 042	11 674	11 330	12 073	10 684	11 506	12 243	9 724	**8 312**
Thermal coal	tonnes (000)	146 968	147 225	146 439	150 677	146 443	156 419	149 471	153 111	129 738	60 713	19 729	20 648	22 975	21 886	18 638	17 254	13 933	**89 545**
Copper	tonnes (000)	904	887	867	753	784	804	738	699	805	678	520	549	632	603	504	523	478	**690**
Diamonds	carats (000)	26 100	33 620	33 272	25 202	35 635	35 162	26 023	20 816	14 026	13 843	11 733	13 122	16 027	13 872	17 392	17 953	21 627	**22 084**
Gold	troy oz (000)	3 577	3 135	2 731	1 552	1 726	1 003	1 233	501	1 111	772	669	294	340	469	376	294	260	**1 179**
Iron Ore	troy oz (000)	90 566	90 951	102 613	107 757	124 494	132 780	144 707	153 394	171 547	184 629	191 767	198 869	208 966	233 557	263 048	281 321	282 484	**174 321**
Lead	tonnes (000)	39	40	48	25	12	12	12	3	-	-	-	-	-	-	-	-	-	**24**
Molybdenum	tonnes (000)	8	6	5	7	16	17	15	11	11	13	14	9	6	12	8	3	5	**10**
Nickel	tonnes (000)	10	6	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**8**
Salt	tonnes (000)	4 248	4 667	4 633	4 792	5 507	5 405	5 242	6 135	5 848	5 188	6 608	6 833	6 728	6 793	5 539	5 180	5 090	**5 555**
Silver	troy oz (000)	17 703	17 207	18 311	14 830	3 538	4 152	4 365	3 252	8 569	6 862	4 924	3 657	4 765	4 699	1 843	1 815	2 378	**7 228**
Tin	tonnes (000)	588	169	100	59	-	-	-	-	-	-	-	-	-	-	-	-	-	**229**
Titanium dioxide slag	tonnes (000)	1 427	1 274	1 192	1 192	1 312	1 415	1 458	1 524	1 147	1 392	1 443	1 594	1 622	1 443	1 089	1 048	1 315	**1 346**
Uranium	pounds (000)	4 705	4 955	5 158	5 974	6 582	12 561	12 616	14 200	14 140	11 377	7 058	9 675	8 105	4 089	4 907	6 342	6 650	**8 182**
Zinc	tonnes (000)	103	95	113	74	37	33	36	10	-	-	-	-	-	-	-	-	-	**63**

Appendix 11.22: Rio Tinto production and commodity prices - part three

(Source: Rio Tinto, 2001 - 2017)

Description	Units	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Average
Sales revenue - Nominal																			
Alumina	$ million	366	400	422	540	823	1 131	1 608	3 612	1 701	1 900	2 140	2 274	2 090	2 158	2 145	2 118	2 661	**1 652**
Aluminium	$ million	1 033	1 058	1 111	1 313	1 538	1 899	3 964	10 568	7 090	7 648	9 082	7 493	6 890	5 929	5 860	6 432	6 264	**5 010**
Bauxite	$ million	378	371	398	478	662	876	1 336	2 162	1 341	1 586	1 999	1 710	2 012	1 956	2 057	1 913	2 019	**1 368**
Borates	$ million	204	188	227	368	469	846	965	1 061	882	1 015	901	656	657	675	624	620	630	**646**
Coking coal	$ million	64	65	76	251	360	311	279	496	687	1 276	3 429	2 538	2 136	1 582	1 369	1 370	1 762	**1 062**
Thermal coal	$ million	2 039	2 140	2 051	2 394	3 139	3 411	3 553	6 515	3 183	3 327	2 767	2 460	2 277	1 978	1 388	1 264	1 067	**2 644**
Copper	$ million	1 435	1 389	1 548	2 158	2 888	5 403	5 255	4 928	4 151	5 113	4 583	4 368	4 622	4 135	2 769	2 550	2 951	**3 544**
Diamonds	$ million	818	372	556	744	1 076	838	1 020	840	450	682	727	741	852	901	698	613	706	**743**
Gold	$ million	973	972	991	635	768	605	857	437	1 080	869	1 052	491	480	594	437	367	327	**702**
Iron Ore	$ million	1 691	1 757	2 145	2 605	5 497	6 938	8 799	15 975	12 066	23 526	29 306	24 279	25 944	23 281	14 731	16 317	20 056	**13 818**
Lead	$ million	22	22	25	24	11	14	32	6	-	-	-	-	-	-	-	-	-	**19**
Molybdenum	$ million	71	67	61	300	1 204	926	821	724	822	427	450	249	138	203	101	43	88	**394**
Nickel	$ million	60	43	58	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**53**
Salt	$ million	61	66	74	123	182	327	269	377	453	442	434	416	404	398	306	259	215	**283**
Silver	$ million	76	74	85	83	24	36	56	48	131	120	144	106	141	90	29	25	38	**77**
Tin	$ million	2 604	670	495	521	-	-	-	-	-	-	-	-	-	-	-	-	-	**1 072**
Titanium dioxide slag	$ million	357	329	333	386	775	990	1 673	1 919	1 284	1 331	1 580	2 232	2 251	2 168	1 571	1 419	1 763	**1 315**
Uranium	$ million	205	225	217	298	368	468	789	966	996	1 026	1 125	352	309	221	474	456	417	**524**
Zinc	$ million	93	78	91	78	46	113	120	19	-	-	-	-	-	-	-	-	-	**80**
Total		**12 548**	**10 284**	**10 965**	**13 300**	**19 831**	**25 131**	**31 396**	**50 652**	**36 318**	**50 286**	**59 718**	**50 364**	**51 204**	**46 268**	**34 558**	**35 765**	**40 965**	34 091
Pearson correlation coefficient - sales and price		**0.94**																	
Sales revenue - Real Terms 2000																			
Alumina	$ million	356	383	395	492	725	966	1 335	2 889	1 366	1 500	1 638	1 706	1 545	1 570	1 558	1 520	1 870	**1 283**
Aluminium	$ million	1 004	1 013	1 040	1 197	1 356	1 622	3 292	8 452	5 691	6 040	6 953	5 620	5 093	4 313	4 257	4 614	4 402	**3 880**
Bauxite	$ million	367	355	372	436	584	748	1 109	1 729	1 077	1 252	1 530	1 283	1 487	1 423	1 494	1 373	1 419	**1 061**
Borates	$ million	198	180	213	336	414	723	801	849	708	802	690	492	486	491	453	445	443	**513**
Coking coal	$ million	62	63	71	229	318	266	232	397	551	1 007	2 625	1 903	1 579	1 151	995	983	1 238	**804**
Thermal coal	$ million	1 983	2 048	1 920	2 182	2 767	2 913	2 950	5 210	2 555	2 628	2 118	1 845	1 683	1 439	1 008	907	750	**2 171**
Copper	$ million	1 395	1 329	1 449	1 968	2 546	4 615	4 364	3 941	3 332	4 038	3 508	3 276	3 417	3 008	2 012	1 829	2 074	**2 829**
Diamonds	$ million	795	356	520	678	949	716	847	672	361	539	557	556	630	655	507	440	496	**604**
Gold	$ million	946	930	928	579	677	517	712	349	867	686	805	368	355	432	317	263	230	**586**
Iron Ore	$ million	1 644	1 682	2 008	2 375	4 847	5 926	7 308	12 777	9 685	18 579	22 435	18 210	19 178	16 934	10 702	11 707	14 094	**10 594**
Lead	$ million	21	21	24	22	10	12	27	5	-	-	-	-	-	-	-	-	-	**18**
Molybdenum	$ million	69	64	57	273	1 061	791	682	579	660	337	344	187	102	148	73	31	62	**325**
Nickel	$ million	58	41	54	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**51**
Salt	$ million	59	63	70	112	161	279	223	302	364	349	332	312	299	290	222	186	151	**222**
Silver	$ million	74	71	80	76	21	30	46	38	105	94	110	80	105	66	21	18	27	**62**
Tin	$ million	2 532	641	463	475	-	-	-	-	-	-	-	-	-	-	-	-	-	**1 028**
Titanium dioxide slag	$ million	347	315	312	352	684	845	1 389	1 535	1 031	1 051	1 210	1 674	1 664	1 577	1 141	1 018	1 239	**1 023**
Uranium	$ million	199	215	203	272	324	400	655	773	799	810	861	264	228	161	344	327	293	**419**
Zinc	$ million	90	74	85	71	41	97	100	15	-	-	-	-	-	-	-	-	-	**72**
Total		**12 201**	**9 845**	**10 264**	**12 125**	**17 486**	**21 466**	**26 075**	**40 512**	**29 151**	**39 711**	**45 717**	**37 774**	**37 849**	**33 655**	**25 107**	**25 660**	**28 787**	26 670
Pearson correlation coefficient - sales and price		**0.96**																	

Appendix 11.23: Rio Tinto basket price index calculation - part one

(Source: Rio Tinto, 2001 - 2017)

Description	Units	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Average
Commodity % Contribution to Total Sales																			
Alumina	%	3%	4%	4%	4%	4%	4%	5%	7%	5%	4%	4%	5%	4%	5%	6%	6%	6%	**5%**
Aluminium	%	8%	10%	10%	10%	8%	8%	13%	21%	20%	15%	15%	15%	13%	13%	17%	18%	15%	**13%**
Bauxite	%	3%	4%	4%	4%	3%	3%	4%	4%	4%	3%	3%	3%	4%	4%	6%	5%	5%	**4%**
Borates	%	2%	2%	2%	3%	2%	3%	3%	2%	2%	2%	2%	1%	1%	1%	2%	2%	2%	**2%**
Coking coal	%	1%	1%	1%	2%	2%	1%	1%	1%	2%	3%	6%	5%	4%	3%	4%	4%	4%	**3%**
Thermal coal	%	16%	21%	19%	18%	16%	14%	11%	13%	9%	7%	5%	5%	4%	4%	4%	4%	3%	**10%**
Copper	%	11%	14%	14%	16%	15%	21%	17%	10%	11%	10%	8%	9%	9%	9%	8%	7%	7%	**12%**
Diamonds	%	7%	4%	5%	6%	5%	3%	3%	2%	1%	1%	1%	1%	2%	2%	2%	2%	2%	**3%**
Gold	%	8%	9%	9%	5%	4%	2%	3%	1%	3%	2%	2%	1%	1%	1%	1%	1%	1%	**3%**
Iron Ore	%	13%	17%	20%	20%	28%	28%	28%	32%	33%	47%	49%	48%	51%	50%	43%	46%	49%	**35%**
Lead	%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
Molybdenum	%	1%	1%	1%	2%	6%	4%	3%	1%	2%	1%	1%	0%	0%	0%	0%	0%	0%	**1%**
Nickel	%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
Salt	%	0%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	**1%**
Silver	%	1%	1%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
Tin	%	21%	7%	5%	4%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**9%**
Titanium dioxide slag	%	3%	3%	3%	3%	4%	4%	5%	4%	4%	3%	3%	4%	4%	5%	5%	4%	4%	**4%**
Uranium	%	2%	2%	2%	2%	2%	2%	3%	2%	3%	2%	2%	1%	1%	0%	1%	1%	1%	**2%**
Zinc	%	1%	1%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**1%**
Total	**%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
Commodity Price Index (Real Terms)																			
Alumina	%	84%	82%	82%	92%	102%	124%	144%	134%	96%	103%	117%	102%	92%	88%	84%	77%	96%	**100%**
Aluminium	%	85%	83%	83%	93%	103%	125%	145%	135%	97%	104%	118%	106%	93%	83%	83%	82%	81%	**100%**
Bauxite	%	85%	83%	83%	93%	103%	126%	146%	135%	97%	104%	118%	89%	94%	93%	94%	79%	77%	**100%**
Borates	%	35%	34%	38%	60%	74%	132%	144%	140%	168%	161%	138%	107%	99%	97%	96%	89%	86%	**100%**
Coking coal	%	39%	40%	38%	42%	55%	56%	47%	66%	66%	104%	279%	208%	162%	134%	107%	100%	158%	**100%**
Thermal coal	%	33%	34%	32%	35%	46%	45%	48%	82%	47%	104%	259%	215%	177%	158%	130%	127%	130%	**100%**
Copper	%	36%	35%	39%	61%	76%	134%	138%	132%	97%	139%	157%	139%	126%	116%	93%	82%	101%	**100%**
Diamonds	%	101%	35%	52%	89%	88%	67%	108%	107%	85%	129%	157%	140%	130%	157%	97%	81%	76%	**100%**
Gold	%	37%	41%	47%	52%	55%	72%	81%	97%	109%	124%	168%	175%	146%	129%	118%	125%	123%	**100%**
Iron Ore	%	32%	33%	35%	39%	69%	79%	90%	148%	100%	179%	208%	163%	163%	129%	72%	74%	89%	**100%**
Lead	%	54%	52%	50%	87%	81%	100%	226%	150%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**100%**
Molybdenum	%	30%	37%	44%	142%	241%	166%	162%	193%	206%	92%	90%	70%	63%	45%	34%	39%	44%	**100%**
Nickel	%	44%	50%	69%	97%	100%	159%	238%	129%	91%	133%	134%	101%	85%	94%	66%	53%	56%	**100%**
Salt	%	36%	35%	39%	61%	76%	134%	110%	127%	161%	174%	130%	118%	115%	110%	104%	93%	77%	**100%**
Silver	%	37%	36%	38%	45%	54%	65%	94%	104%	108%	122%	198%	193%	194%	123%	102%	87%	100%	**100%**
Tin	%	83%	73%	89%	155%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**100%**
Titanium dioxide slag	%	32%	33%	35%	39%	69%	80%	127%	134%	120%	101%	112%	140%	137%	146%	140%	130%	126%	**100%**
Uranium	%	32%	33%	35%	39%	69%	80%	127%	134%	120%	101%	112%	140%	137%	146%	140%	130%	126%	**100%**
Zinc	%	60%	54%	51%	66%	75%	198%	192%	104%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**100%**

Appendix 11.24: Rio Tinto basket price index calculation - part two

(Source: Rio Tinto, 2001 - 2017)

Description	Units	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Commodity Price Index Weighted by Volume																		
Alumina	%	0.02	0.03	0.03	0.04	0.04	0.06	0.07	0.10	0.05	0.04	0.04	0.05	0.04	0.04	0.05	0.05	0.06
Aluminium	%	0.07	0.09	0.08	0.09	0.08	0.09	0.18	0.28	0.19	0.16	0.18	0.16	0.13	0.11	0.14	0.15	0.12
Bauxite	%	0.03	0.03	0.03	0.03	0.03	0.04	0.06	0.06	0.04	0.03	0.04	0.03	0.04	0.04	0.06	0.04	0.04
Borates	%	0.01	0.01	0.01	0.02	0.02	0.04	0.04	0.03	0.04	0.03	0.02	0.01	0.01	0.01	0.02	0.02	0.01
Coking coal	%	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.01	0.01	0.03	0.16	0.10	0.07	0.05	0.04	0.04	0.07
Thermal coal	%	0.05	0.07	0.06	0.06	0.07	0.06	0.05	0.11	0.04	0.07	0.12	0.11	0.08	0.07	0.05	0.04	0.03
Copper	%	0.04	0.05	0.06	0.10	0.11	0.29	0.23	0.13	0.11	0.14	0.12	0.12	0.11	0.10	0.07	0.06	0.07
Diamonds	%	0.07	0.01	0.03	0.05	0.05	0.02	0.04	0.02	0.01	0.02	0.02	0.02	0.02	0.03	0.02	0.01	0.01
Gold	%	0.03	0.04	0.04	0.02	0.02	0.02	0.02	0.01	0.03	0.02	0.03	0.02	0.01	0.02	0.01	0.01	0.01
Iron Ore	%	0.04	0.06	0.07	0.08	0.19	0.22	0.25	0.47	0.33	0.84	1.02	0.78	0.83	0.65	0.31	0.34	0.43
Lead	%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	-	-	-	-	-	-	-	-
Molybdenum	%	0.00	0.00	0.00	0.03	0.15	0.06	0.04	0.03	0.05	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Nickel	%	0.00	0.00	0.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Salt	%	0.00	0.00	0.00	0.01	0.01	0.02	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.00
Silver	%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
Tin	%	0.17	0.05	0.04	0.06	-	-	-	-	-	-	-	-	-	-	-	-	-
Titanium dioxide slag	%	0.01	0.01	0.01	0.01	0.03	0.03	0.07	0.05	0.04	0.03	0.03	0.06	0.06	0.07	0.06	0.05	0.05
Uranium	%	0.01	0.01	0.01	0.01	0.01	0.01	0.03	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.02	0.02	0.01
Zinc	%	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	-	-	-	-	-	-	-	-	-
Basket price index weighted by sales		**0.56**	**0.46**	**0.48**	**0.63**	**0.82**	**0.99**	**1.12**	**1.31**	**1.00**	**1.45**	**1.82**	**1.49**	**1.42**	**1.20**	**0.87**	**0.83**	**0.94**

Appendix 11.25: Vale economic data - part one

(Source: Vale, 2001 - 2017)

Description	Units	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total / average
US$ inflation index		1.03	1.04	1.07	1.10	1.13	1.17	1.20	1.25	1.25	1.27	1.31	1.33	1.35	1.37	1.38	1.39	1.42	
Year-end open capital commitments $ millions	$ millions	624	772	957	1 989	2 445	3 813	5 096	4 507	6 353	8 997	8 098	7 117	5 990	4 201	2 741	1 924	1 919	
Capital expenditure	$ millions	595	721	1 543	1 913	3 977	4 890	7 625	10 192	9 013	12 705	17 994	16 196	14 233	11 979	8 401	5 481	3 848	**131 306**
Capital expenditure as % of revenue	%	15%	17%	29%	24%	31%	30%	27%	31%	46%	32%	30%	35%	30%	47%	36%	20%	11%	**29%**
Capital expenditure as % of operating costs	%	26%	32%	49%	47%	64%	48%	46%	56%	57%	62%	70%	61%	66%	53%	45%	31%	18%	**48.9%**
Capital expenditure (real 2000 terms)	$ millions	579	690	1 444	1 744	3 507	4 177	6 333	8 152	7 234	10 033	13 775	12 147	10 521	8 713	6 104	3 932	2 704	**101 789**
Expansionary capital expenditure	$ millions	410	497	1 064	1 266	2 604	3 530	5 423	7 520	6 855	9 375	13 426	11 580	9 648	7 920	5 548	3 179	1 617	**91 463**
Stay-in business capital expenditure	$ millions	185	224	479	647	757	1 360	2 202	2 672	2 158	3 330	4 568	4 616	4 585	4 059	2 853	2 302	2 231	**39 227**
Net cash outflow from acquisition	$ millions	516	45	448	143	840	15 738	3 379	-	-	-	-	-	-	-	-	-	-	**21 109**
Acquistions as % of revenue	%	13%	1%	8%	2%	7%	95%	12%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	
Net cash inflow from disposals	$ millions	992	7	141	579	126	837	1 042	134	1 952	6 252	1 513	974	2 030	1 246	1 456	543	972	**20 796**
Net cash from acquisitions plus disposals	$ millions	-476	38	307	-436	714	14 901	2 337	-134	-1 952	-6 252	-1 513	-974	-2 030	-1 246	-1 456	-543	-972	**313**
Net acquistion and disposal cash flow plus capital	$ millions	119	759	1 850	1 477	4 691	19 791	9 962	10 058	7 061	6 453	16 481	15 222	12 203	10 733	6 945	4 938	2 876	**131 619**
Net cash used in investing activities	**$ millions**	**119**	**759**	**1 850**	**1 477**	**4 691**	**19 791**	**9 962**	**10 058**	**7 061**	**6 453**	**16 481**	**15 222**	**12 203**	**10 733**	**6 945**	**4 938**	**2 876**	131 619
Net capital allocated to investing activities as % of	**$ millions**	**5%**	**34%**	**59%**	**36%**	**75%**	**195%**	**61%**	**56%**	**45%**	**31%**	**65%**	**57%**	**56%**	**47%**	**37%**	**28%**	**14%**	53.0%
Net cash used in investing activities (real 2000	**$ millions**	**116**	**727**	**1 732**	**1 346**	**4 136**	**16 905**	**8 274**	**8 044**	**5 668**	**5 096**	**12 617**	**11 417**	**9 020**	**7 807**	**5 046**	**3 543**	**2 021**	103 514
New capital commitments $ millions	$ millions	595	869	1 728	2 945	4 434	6 258	8 909	9 603	10 859	15 350	17 095	15 215	13 106	10 190	6 941	4 665	3 843	**132 601**
New capital commitments $ millions (real 2000	$ millions	579	831	1 618	2 685	3 909	5 345	7 399	7 680	8 716	12 122	13 087	11 411	9 688	7 412	5 043	3 347	2 700	**103 570**
Revenue	$ millions	3 935	4 123	5 350	8 066	12 792	16 511	28 441	32 484	19 502	39 422	60 075	46 553	46 767	25 609	23 384	27 488	33 967	**434 469**
Revenue (real 2000 terms)	$ millions	3 826	3 947	5 008	7 353	11 279	14 103	23 621	25 981	15 653	31 132	45 990	34 916	34 570	18 628	16 989	19 722	23 869	**336 586**
Operational costs	$ millions	2 272	2 263	3 128	4 081	6 229	10 147	16 463	18 099	15 747	20 550	25 529	26 591	21 668	22 790	18 751	17 650	21 039	**252 997**
Operational costs (real 2000 terms)	$ millions	2 209	2 166	2 928	3 720	5 492	8 667	13 673	14 476	12 639	16 228	19 543	19 944	16 017	16 577	13 623	12 663	14 785	**195 352**
Operational costs as % of revenue	%	58%	55%	58%	51%	49%	61%	58%	56%	81%	52%	42%	57%	46%	89%	80%	64%	62%	**60%**
Total capital (Sum of shareholders equity, and net debt)	$ millions	6 887	5 723	7 728	10 682	19 368	41 633	51 057	60 168	79 713	93 469	100 870	105 097	94 381	126 095	90 497	66 066	62 915	**1 022 350**
Shareholders equity	$ millions	4 640	3 287	4 884	7 391	11 977	19 763	33 276	42 556	59 766	71 729	77 815	74 827	64 936	56 321	35 704	41 024	44 772	**654 668**
Shareholders equity (real 2000 terms)	$ millions	4 512	3 147	4 572	6 738	10 560	16 881	27 636	34 036	47 972	56 645	59 571	56 122	48 000	40 967	25 940	29 434	31 462	**504 194**
Net debt	$ millions	2 247	2 436	2 844	3 291	7 391	21 870	17 781	17 612	19 947	21 740	23 055	30 270	29 445	28 807	28 853	25 042	18 143	**300 774**
Gearing ratio %	%	48%	74%	58%	45%	62%	111%	53%	41%	33%	30%	30%	40%	45%	51%	81%	61%	41%	**53%**
New capital commitments as % of total capital	%	8.6%	15.2%	22.4%	27.6%	22.9%	15.0%	17.4%	16.0%	13.6%	16.4%	16.9%	14.5%	13.9%	8.1%	7.7%	7.1%	6.1%	**15%**
New capital commitments as % of turnover	%	15.1%	21.1%	32.3%	36.5%	34.7%	37.9%	31.3%	29.6%	55.7%	38.9%	28.5%	32.7%	28.0%	39.8%	29.7%	17.0%	11.3%	**31%**
Capital expenditure as percentage of total capital	%	8.6%	12.6%	20.0%	17.9%	20.5%	11.7%	14.9%	16.9%	11.3%	13.6%	17.8%	15.4%	15.1%	9.5%	9.3%	8.3%	6.1%	**14%**

Appendix 11.26: Vale economic data - part two

(Source: Vale, 2001 - 2017)

Description	**Units**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**Total / average**
Profit before tax and special items	$ millions	1 120	601	1 654	3 003	5 420	7 829	15 233	13 217	7 123	20 314	27 913	4 091	7 241	1 553	-17 679	7 984	7 829	**114 446**
Profit after tax	$ millions	1 287	680	1 548	2 573	4 841	6 528	11 825	13 476	5 456	17 453	22 562	5 197	406	353	-12 620	3 976	5 521	**91 062**
Net cash inflows from operating activities	$ millions	1 518	2 101	1 757	3 471	5 161	7 232	11 012	17 114	7 136	19 183	24 496	16135	14792	12 807	3 932	6 401	12 450	**166 698**
Net cash inflows from operating activities as % of	%	39%	51%	33%	43%	40%	44%	39%	53%	37%	49%	41%	35%	32%	50%	17%	23%	37%	**39%**
Net cash inflows from operating activities and	%	64%	51%	35%	50%	41%	49%	42%	53%	47%	65%	43%	37%	36%	55%	23%	25%	40%	**44%**
Net cash flows to net debt ratio	%	68%	86%	62%	105%	70%	33%	62%	97%	36%	88%	106%	53%	50%	44%	14%	26%	69%	**63%**
Impairment charges	$ millions	-	-	-	-	-	-	-	-950	-	-	-	-4 023	-2 298	-1 152	-4 068	-2 460	-474	**-15 425**
EBITDA	$ millions	1 174	1 643	1 902	3 522	6 051	8 634	15 380	18 505	8 779	24 955	34 160	17 587	21 511	12 618	7 081	12 181	15 342	**211 025**
EBITDA (real 2000 terms)	$ millions	1 142	1 573	1 780	3 211	5 335	7 375	12 773	14 800	7 047	19 707	26 151	13 191	15 901	9 178	5 145	8 740	10 781	**163 829**
Income taxes	$ millions	-218	-149	297	749	880	1 432	3 201	1 083	628	1 188	5 262	-1 174	6 833	1 200	-5 249	2 781	1 495	**20 239**
NOPAT	$ millions	1 392	1 792	1 605	2 773	5 171	7 202	12 179	17 422	8 151	23 767	28 898	18 761	14 678	11 418	12 330	9 400	13 847	**190 786**
Sales	$ millions	3 935	4 123	5 350	8 066	12 792	16 511	28 441	32 484	19 502	39 422	60 075	46 553	46 767	25 609	23 384	27 488	33 967	**434 469**
NOPAT/ Sales		35%	43%	30%	34%	40%	44%	43%	54%	42%	60%	48%	40%	31%	45%	53%	34%	41%	**42%**
Dividends paid to shareholders	$ millions	1 066	602	675	787	1 300	1 300	1 875	2 850	2 724	3 000	9 000	6 000	4 500	4 200	1 500	250	1 456	**43 085**
Total distributions to shareholders as % of revenue	%	27%	15%	13%	10%	10%	8%	7%	9%	14%	8%	15%	13%	10%	16%	6%	1%	4%	**11%**
Total distributions to shareholders as % of total	%	11%	8%	6%	5%	6%	2%	2%	4%	3%	2%	7%	5%	4%	4%	2%	0%	1%	**4%**
Invested capital	$ millions	8 640	7 412	10 438	13 927	19 396	54 362	66 807	72 771	90 315	108 788	117 340	121 646	117 208	107 282	80 560	90 575	88 909	**1 176 376**
Invested capital less cash	$ millions	7 523	6 321	9 853	11 411	14 948	53 321	65 761	62 440	83 022	101 204	113 809	115 814	111 887	103 308	76 969	86 313	84 581	**1 108 485**
Sales/ Invested capital		46%	56%	51%	58%	66%	30%	43%	45%	22%	36%	51%	38%	40%	24%	29%	30%	38%	**41%**
ROCE	%	12.7%	22.2%	18.1%	24%	28%	14%	20%	22%	7%	20%	26%	11%	15%	8%	4%	10%	13%	**16.1%**
ROIC	%	16.1%	24.2%	15.4%	19.9%	26.7%	13.2%	18.2%	23.9%	9.0%	21.8%	24.6%	15.4%	12.5%	10.6%	15.3%	10.4%	15.6%	**17.2%**
Capital allocated to investment as % of opex * commodity price index (CIPCI)		2%	14%	28%	22%	61%	249%	86%	77%	45%	57%	141%	99%	94%	58%	30%	24%	15%	**64.7%**

Appendix 11.27: Vale ROIC and ROCE calculation

(Source: Vale, 2001 - 2017)

Description	Unit	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
ROIC Calculation																		
Net working capital	**$ millions**	**1 770**	**2 046**	**1 478**	**2 102**	**1 527**	**6 376**	**1 470**	**16 078**	**11 300**	**13 720**	**11 962**	**13 138**	**13 222**	**7 387**	**3 497**	**14 128**	**8 679**
Total current assets	$ millions	2 638	2 589	2 474	3 890	4 775	12 940	11 380	23 238	20 459	31 559	21 538	22 069	20 611	16 594	11 429	22 567	18 954
Non-interest bearing current liabilities	$ millions	-868	-543	-996	-1 788	-3 248	-6 564	-9 910	-7 160	-9 159	-17 839	-9 576	-8 931	-7 389	-9 207	-7 932	-8 439	-10 275
Current liabilities	$ millions	1 921	1 508	2 253	2 455	3 325	7 312	10 083	7 237	9 208	17 987	11 093	12 402	9 164	10 626	10 438	10 142	11 935
Interest bearing current liabilities	$ millions	1 053	965	1 257	667	77	748	173	77	49	148	1 517	3 471	1 775	1 419	2 506	1 703	1 660
Total non-current assets	$ millions	6 870	5 366	8 960	11 825	17 869	47 986	65 337	56 693	79 015	95 068	105 378	108 508	103 986	99 895	77 063	76 447	80 230
Invested capital	$ millions	8 640	7 412	10 438	13 927	19 396	54 362	66 807	72 771	90 315	108 788	117 340	121 646	117 208	107 282	80 560	90 575	88 909
Cash or cash equivalents	$ millions	1 117	1 091	585	2 517	4 448	1 041	1 046	10 331	7 293	7 584	3 531	5 832	5 321	3 974	3 591	4 262	4 328
Invested capital excluding cash	$ millions	7 523	6 321	9 853	11 411	14 948	53 321	65 761	62 440	83 022	101 204	113 809	115 814	111 887	103 308	76 969	86 313	84 581
Return on invested capital ROIC)	%	16%	24%	15%	20%	27%	13%	18%	24%	9%	22%	25%	15%	13%	11%	15%	10%	16%
ROCE Calculation																		
EBIT	$ millions	962	1 429	1 664	3 123	5 432	7 637	13 194	15 698	6 057	21 695	30 324	13 432	17 361	8 330	3 052	8 694	11 634
Operating Income	$ millions	962	1 429	1 664	3 123	5 432	7 637	13 194	14 748	6 057	21 695	30 324	9 409	15 063	7 178	-5 874	12 181	15 342
Impairment of non current assets	$ millions	-	-	-	-	-	-	-	950	-	-	-	4 023	2 298	1 152	8 926	12 181	15 342
Depreciation and amortisiation	$ millions	212	214	238	399	619	997	2 186	2 807	2 722	3 260	3 836	4 155	4 150	4 288	4 029	3 487	3 708
EBITDA	$ millions	1 174	1 643	1 902	3 522	6 051	8 634	15 380	18 505	8 779	24 955	34 160	17 587	21 511	12 618	7 081	12 181	15 342
less depreciation and amortisiation	$ millions	-212	-214	-238	-399	-619	-997	-2 186	-2 807	-2 722	-3 260	-3 836	-4 155	-4 150	-4 288	-4 029	-3 487	-3 708
Total assets	$ millions	9 508	7 955	11 434	15 715	22 644	60 926	76 717	79 931	99 474	126 627	126 916	130 577	124 597	116 489	88 492	99 014	99 184
Current liabilities	$ millions	1 921	1 508	2 253	2 455	3 325	7 312	10 083	7 237	9 208	17 987	11 093	12 402	9 164	10 626	10 438	10 142	11 935
Capital employed	$ millions	7 587	6 447	9 181	13 260	19 319	53 614	66 634	72 694	90 266	108 640	115 823	118 175	115 433	105 863	78 054	88 872	87 249
Return on capital employed (ROCE)	%	13%	22%	18%	24%	28%	14%	20%	22%	7%	20%	26%	11%	15%	8%	4%	10%	13%

Appendix 11.28: Vale production and commodity prices - part one

(Source: Vale, 2001 - 2017)

Description	Units	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Average
Rand/US$ Exchange Rate		8.62	10.48	7.55	6.44	6.37	6.77	7.05	8.27	8.41	7.32	7.26	8.21	9.65	10.85	12.78	14.7	13.31	**9.06**
Sterling/US$ Exchange Rate		0.69	0.67	0.61	0.55	0.55	0.54	0.5	0.54	0.64	0.65	0.62	0.63	0.64	0.61	0.65	0.74	0.78	**0.62**
Euro/US$ Exchange Rate		1.12	1.06	0.88	0.8	0.8	0.8	0.73	0.68	0.72	0.75	0.72	0.78	0.75	0.75	0.9	0.9	0.89	**0.83**
Australian Dollar/US$ Exchange Rate		1.93	1.84	1.53	1.36	1.31	1.33	1.19	1.17	1.26	1.09	0.97	0.97	1.03	1.11	1.33	1.34	1.3	**1.30**
Chilean Peso/US$ Exchange Rate				690	609	559	530	522	524	559	510	484	486	495	571	655	676	649	**567.93**
Brazilian real									1.84	2	1.76	1.67	1.95	2.16	2.35	3.34	3.48	3.19	**2.37**
US CPI Inflation		2.8%	1.6%	2.3%	2.7%	3.4%	3.2%	2.8%	3.8%	-0.4%	1.6%	3.2%	2.1%	1.5%	1.6%	0.1%	1.3%	2.1%	
US CPI Index		1.03	1.04	1.07	1.10	1.13	1.17	1.20	1.25	1.25	1.27	1.31	1.33	1.35	1.37	1.38	1.39	1.42	
Commodity Prices (Nominal)																			
Average market prices for the year																			
Alumina	US$/tonne	208	205	210	256	290	344	339	348	226	283	366	326	297	289	275	259	327	**285**
Bauxite	US$/tonne	32	32	32	25	28	30	36	41	34	31	56	43	47	47	47	40	40	**38**
Metallurgical coal	US$/tonne	32	34	33	37	50	53	67	170	115	150	235	171	129	104	85	119	172	**105**
Thermal coal	US$/tonne	14	15	14	16	21	22	53	85	66	70	95	82	81	67	52	46	71	**54**
Cobalt	US$/tonne	15 400	13 200	18 000	23 000	33 000	32 915	54 146	66 000	22 000	33 268	34 458	27 051	24 141	23 523	21 936	24 273	51 513	**30 460**
Copper	US$/tonne	1 587	1 565	1 786	2 866	3 682	6 380	6 611	6 331	5 229	7 730	8 420	7 595	6 709	6 015	4 352	4 459	5 970	**5 135**
Ferroalloys Manganese	US$/carrat	696	597	683	956	847	887	1 312	2 709	1 395	1 547	1 443	1 340	1 303	1 453	1 020	1 020	1 020	**1 190**
Gold	US$/oz	272	310	363	409	445	603	695	872	972	1 125	1 572	1 669	1 411	1 266	1 160	1 250	1 257	**921**
Iron Ore	US$/tonne	12	13	14	20	33	40	45	67	56	104	136	110	112	76	45	54	64	**59**
Iron ore pellets	US$/tonne	15	16	17	40	71	75	78	131	74	161	194	149	150	124	78	80	109	**55**
Managnese ore	US$/tonne	155	150	161	123	100	75	107	350	147	230	166	134	157	120	56	110	159	**147**
Nickel	US$/tonne	5 886	6 768	9 634	13 845	14 727	31 982	37 442	21 010	14 596	21 980	22 680	17 866	14 900	16 426	11 684	9 800	10 654	**16 581**
Platinum	US$/oz	531	541	692	847	897	1 116	1 304	1 585	1 211	1 610	1 725	1 555	1 487	1 385	1 051	989	950	**1 146**
Palladium	US$/oz	597	336	201	231	201	321	355	355	266	527	736	647	725	803	691	615	871	**499**
Phosphate	US$/tonne	0	0	0	0	0	0	0	0	0	230	325	447	340	287	273	261	0	**309**
Potash	US$/tonne	119	145	143	197	233	195	264	591	521	410	505	530	417	355	0	0	0	**330**
Kaoline	US$/lb	36	43	85	136	145	165	195	194	216	0	0	0	0	0	0	0	0	**135**

Appendix 11.29: Vale production and commodity prices - part two

(Source: Vale, 2001 - 2017)

Description	Units	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Commodity Prices (Real 2000 Prices)																		
Alumina	US$/tonne	202	197	196	233	256	294	281	278	181	223	280	245	220	210	200	185	230
Bauxite	US$/tonne	31	30	30	23	25	26	30	33	27	24	43	33	34	34	34	29	28
Metallurgical coal	US$/tonne	32	33	31	34	44	45	56	136	92	118	180	128	95	76	62	85	121
Thermal coal	US$/tonne	13	14	13	14	19	19	44	68	53	55	73	62	60	49	38	33	50
Cobalt	US$/tonne	14974	12636	16849	20967	29097	28115	44969	52787	17658	26272	26379	20289	17845	17111	15937	17415	36199
Copper	US$/tonne	1543	1498	1672	2613	3246	5450	5491	5064	4197	6104	6446	5696	4959	4375	3162	3199	4195
Ferroalloys Manganese	US$/carrat	677	572	639	872	747	758	1089	2167	1120	1222	1105	1005	963	1057	741	732	717
Gold	US$/oz	264	297	340	373	392	515	577	697	780	888	1203	1252	1043	921	843	897	883
Iron Ore	US$/tonne	12	12	13	18	29	34	37	54	45	82	104	83	83	55	32	39	45
Iron ore pellets	US$/tonne	15	15	16	36	62	64	65	105	59	127	148	112	111	90	57	58	77
Managnese	US$/tonne	151	144	150	112	88	64	89	280	118	182	127	101	116	87	41	79	112
Nickel	US$/tonne	5723	6479	9018	12621	12985	27318	31096	16804	11716	17358	17362	13400	11014	11948	8489	7031	7487
Platinum	US$/tonne	516	518	648	772	791	953	1083	1268	972	1271	1321	1166	1099	1007	764	710	668
Palladium	US$/oz	580	322	188	211	177	274	295	284	214	416	563	485	536	584	502	441	612
Phosphate	US$/tonnes	0	0	0	0	0	0	0	0	0	182	249	335	251	209	198	187	0
Potash	US$/tonne	116	139	134	179	205	167	219	473	418	324	387	398	308	258	0	0	0
Kaoline	US$/lb	116	139	134	179	205	167	219	473	418	324	387	398	308	258	0	0	0
Production Volumes																		
Alumina	tonnes (000)	154	775	2362	1789	2600	3900	3253	4224	5257	0	0	0	0	0	0	0	0
Bauxite	tonnes (000)	655	727	1145	2120	2143	2333	2333	659	206	0	0	0	0	0	0	0	0
Metallurgical coal	tonnes (000)	0	0	0	0	0	0	1764	2808	2527	3057	2766	5083	6885	6443	3401	3480	6953
Thermal coal	tonnes (000)	0	0	0	0	0	0	440	1286	2892	3832	4506	1999	1878	2202	1559	2012	4307
Cobalt	tonnes (000)	0	0	0	0	0	2	3	3	2	1	3	2	4	4	5	6	6
Copper	tonnes (000)	0	0	0	197	237	267	284	312	198	207	302	290	370	380	424	453	446
Ferroalloys Manganese	tonnes (000)	372	474	511	609	602	540	542	475	223	451	436	206	175	171	99	124	146
Gold	troy oz (000)	513	315	54	0	0	78	75	85	147	144	272	164	286	321	420	482	485
Iron Ore	tonnes (000)	164200	168700	188300	211300	233900	264200	310400	310000	246500	307800	322600	320000	310700	322400	358600	348800	366500
Iron ore pellets	tonnes (000)	39500	43200	49000	54100	56100	51800	53700	55200	32600	49300	52300	55100	49600	55100	58500	46200	50300
Managnese ore	tonnes (000)	1900	2300	2200	2700	3000	2300	1300	2400	1700	1800	2500	2400	2400	2400	2400	2400	2200
Nickel	tonnes (000)	0	0	0	0	0	235	248	275	187	179	242	237	260	275	291	311	288
Platinum	troy oz (000)	0	0	0	0	0	153	140	166	103	35	174	134	145	182	154	166	144
Palladium	troy oz (000)	0	0	0	0	0	209	191	231	152	60	248	251	352	398	341	322	214
Phosphate	tonnes (000)	0	0	0	0	0	0	0	0	0	5255	7359	7982	8277	8421	8163	7546	0
Potash	tonnes (000)	595	627	658	638	641	731	671	607	717	662	625	549	492	492	481	501	0
Kaoline	tonnes (000)	1130	1040	1134	1210	1218	1352	1354	1129	781	0	0	0	0	0	0	0	0

Appendix 11.30: Vale production and commodity prices - part three

(Source: Vale, 2001 - 2017)

Description	Units	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Sales revenue - Nominal																		
Alumina	$ million	32	159	495	458	754	1 342	1 102	1 470	1 188	0	0	0	0	0	0	0	0
Bauxite	$ million	21	23	37	53	60	70	85	27	7	0	0	0	0	0	0	0	0
Metallurgical coal	$ million	0	0	0	0	0	0	118	477	291	459	650	869	888	670	289	414	1 196
Thermal coal	$ million	0	0	0	0	0	0	23	109	191	268	428	164	152	148	81	93	306
Cobalt	$ million	0	0	0	0	0	65	137	187	35	35	92	63	85	88	99	141	299
Copper	$ million	0	0	0	565	873	1 703	1 878	1 975	1 035	1 600	2 543	2 203	2 482	2 286	1 845	2 020	2 663
Ferroalloys Manganese	$ million	259	283	349	701	571	508	711	1 211	311	664	561	276	228	248	101	126	149
Gold	$ million	139	103	21	0	0	47	52	74	143	162	428	274	404	406	487	603	610
Iron Ore	$ million	2 003	2 147	2 662	3 995	7 396	10 027	11 908	17 775	12 831	26 384	35 008	26 691	27 844	19 301	12 330	15 784	18 524
Iron ore pellets	$ million	597	673	838	1 148	2 083	1 979	2 738	4 301	1 352	6 402	8 150	6 560	6 000	5 263	3 600	3 827	5 653
Managnese	$ million	295	345	354	333	300	55	77	266	250	258	171	543	523	392	162	302	469
Nickel	$ million	0	0	0	0	0	7 512	9 282	5 786	2 725	3 928	5 477	4 234	3 877	4 516	3 395	3 048	3 070
Platinum	$ million	0	0	0	0	0	171	183	263	125	56	300	208	216	252	162	164	137
Palladium	$ million	0	0	0	0	0	67	68	82	40	32	183	162	255	320	236	198	186
Phosphate	$ million	0	0	0	0	0	0	0	0	0	1 211	2 395	3 570	2 814	2 415	2 225	1 970	0
Potash	$ million	71	91	94	124	149	143	178	295	413	280	287	291	205	175	0	0	0
Kaoline	$ million	41	45	96	164	177	218	238	209	173	0	0	0	0	0	0	0	0
Total		**3458**	**3869**	**4946**	**7540**	**12363**	**23907**	**28777**	**34508**	**21110**	**41739**	**56673**	**46109**	**45973**	**36479**	**25013**	**28689**	**33262**
Pearson correlation coefficient - sales and price		**0.94**																
Sales revenue - Real Terms 2000																		
Alumina	$ million	31	152	463	418	665	1 146	915	1 176	954	0	0	0	0	0	0	0	0
Bauxite	$ million	20	22	35	48	53	60	71	22	6	0	0	0	0	0	0	0	0
Metallurgical coal	$ million	0	0	0	0	0	0	98	382	233	362	498	652	657	487	210	297	840
Thermal coal	$ million	0	0	0	0	0	0	19	87	153	212	328	123	112	107	59	66	215
Cobalt	$ million	0	0	0	0	0	56	114	149	28	28	71	48	63	64	72	101	210
Copper	$ million	0	0	0	515	769	1 455	1 559	1 580	831	1 264	1 947	1 652	1 835	1 663	1 341	1 449	1 871
Ferroalloys Manganese	$ million	252	271	327	639	503	434	590	969	250	524	429	207	169	181	73	91	105
Gold	$ million	135	99	20	0	0	40	43	59	115	128	327	205	298	296	354	432	428
Iron Ore	$ million	1 948	2 055	2 492	3 642	6 521	8 565	9 890	14 216	10 299	20 836	26 800	20 019	20 582	14 039	8 958	11 325	13 017
Iron ore pellets	$ million	580	644	784	1 047	1 837	1 690	2 274	3 440	1 085	5 056	6 239	4 920	4 435	3 828	2 616	2 746	3 972
Managnese	$ million	287	330	331	303	265	47	64	213	201	204	131	407	387	285	118	217	330
Nickel	$ million	0	0	0	0	0	6 417	7 709	4 628	2 187	3 102	4 193	3 176	2 866	3 285	2 467	2 187	2 158
Platinum	$ million	0	0	0	0	0	146	152	210	100	44	230	156	159	183	118	118	96
Palladium	$ million	0	0	0	0	0	57	56	66	32	25	140	122	189	232	171	142	131
Phosphate	$ million	0	0	0	0	0	0	0	0	0	956	1 833	2 678	2 080	1 757	1 617	1 413	0
Potash	$ million	69	87	88	113	131	122	148	236	331	221	220	218	152	127	0	0	0
Kaoline	$ million	40	43	90	150	156	186	198	167	139	0	0	0	0	0	0	0	0
Total		**3 363**	**3 704**	**4 629**	**6 874**	**10 900**	**20 421**	**23 900**	**27 600**	**16 944**	**32 962**	**43 385**	**34 582**	**33 983**	**26 535**	**18 173**	**20 584**	**23 374**
Pearson correlation coefficient - sales and price		**0.97**																

Appendix 11.31: Vale basket price index calculation - part one

(Source: Vale, 2001 - 2017)

Description	Units	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Commodity % Contribution to Total Sales																		
Alumina	%	1%	4%	10%	6%	6%	6%	4%	4%	6%	0%	0%	0%	0%	0%	0%	0%	0%
Bauxite	%	1%	1%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Metallurgical coal	%	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%	1%	2%	2%	2%	1%	1%	4%
Thermal coal	%	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%	0%	0%	0%	0%	0%	1%
Cobalt	%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	1%
Copper	%	0%	0%	0%	7%	7%	7%	7%	6%	5%	4%	4%	5%	5%	6%	7%	7%	8%
Ferroalloys Manganese	%	7%	7%	7%	9%	5%	2%	2%	4%	1%	2%	1%	1%	0%	1%	0%	0%	0%
Gold	%	4%	3%	0%	0%	0%	0%	0%	0%	1%	0%	1%	1%	1%	1%	2%	2%	2%
Iron Ore	%	58%	55%	54%	53%	60%	42%	41%	52%	61%	63%	62%	58%	61%	53%	49%	55%	56%
Iron ore pellets	%	17%	17%	17%	15%	17%	8%	10%	12%	6%	15%	14%	14%	13%	14%	14%	13%	17%
Managnese	%	9%	9%	7%	4%	2%	0%	0%	1%	1%	1%	0%	1%	1%	1%	1%	1%	1%
Nickel	%	0%	0%	0%	0%	0%	31%	32%	17%	13%	9%	10%	9%	8%	12%	14%	11%	9%
Platinum	%	0%	0%	0%	0%	0%	1%	1%	1%	1%	0%	1%	0%	0%	1%	1%	1%	0%
Palladium	%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%	1%	1%
Phosphate	%	0%	0%	0%	0%	0%	0%	0%	0%	0%	3%	4%	8%	6%	7%	9%	7%	0%
Potash	%	2%	2%	2%	2%	1%	1%	1%	1%	2%	1%	1%	1%	0%	0%	0%	0%	0%
Kaoline	%	1%	1%	2%	2%	1%	1%	1%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%
Commodity Price Index (Real Terms)																		
Alumina	%	88%	85%	85%	101%	111%	128%	122%	121%	79%	97%	122%	106%	95%	91%	87%	81%	100%
Bauxite	%	103%	100%	100%	75%	82%	85%	99%	108%	90%	81%	143%	108%	114%	112%	113%	95%	92%
Metallurgical coal	%	39%	40%	38%	42%	55%	56%	69%	169%	115%	147%	224%	159%	119%	94%	77%	106%	150%
Thermal coal	%	34%	35%	33%	36%	48%	47%	111%	171%	133%	139%	183%	155%	151%	123%	95%	83%	125%
Cobalt	%	61%	52%	69%	86%	119%	115%	184%	216%	72%	107%	108%	83%	73%	70%	65%	71%	148%
Copper	%	38%	37%	41%	64%	80%	134%	135%	125%	104%	151%	159%	141%	122%	108%	78%	79%	103%
Ferroalloys Manganese	%	71%	60%	67%	92%	78%	80%	114%	228%	118%	128%	116%	106%	101%	111%	78%	77%	75%
Gold	%	37%	41%	47%	52%	55%	72%	81%	97%	109%	124%	168%	175%	146%	129%	118%	125%	123%
Iron Ore	%	26%	27%	29%	39%	63%	75%	82%	117%	98%	179%	228%	181%	181%	121%	71%	85%	99%
Iron ore pellets	%	21%	21%	22%	51%	87%	90%	91%	146%	83%	178%	207%	156%	155%	126%	79%	80%	107%
Managnese	%	126%	120%	125%	94%	73%	53%	74%	233%	98%	151%	106%	84%	97%	73%	34%	66%	93%
Nickel	%	43%	48%	67%	94%	97%	204%	232%	125%	87%	130%	130%	100%	82%	89%	63%	52%	56%
Platinum	%	57%	57%	71%	85%	87%	104%	119%	139%	106%	139%	145%	128%	120%	110%	84%	78%	73%
Palladium	%	148%	82%	48%	54%	45%	70%	75%	72%	54%	106%	143%	123%	136%	149%	128%	112%	156%
Phosphate	%	0%	0%	0%	0%	0%	0%	0%	0%	0%	79%	108%	146%	109%	91%	86%	81%	0%
Potash	%	44%	52%	50%	67%	77%	63%	82%	178%	157%	122%	145%	149%	116%	97%	0%	0%	0%
Kaoline	%	44%	52%	50%	67%	77%	63%	82%	178%	157%	122%	145%	149%	116%	97%	0%	0%	0%

Appendix 11.32: Vale basket price index calculation – part two

(Source: Vale, 2001 - 2017)

Description	Units	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Commodity Price Index Weighted by Sales																		
Alumina	%	0.01	0.04	0.09	0.06	0.07	0.07	0.05	0.05	0.04	-	-	-	-	-	-	-	-
Bauxite	%	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	-	-	-	-	-	-	-	-
Metallurgical coal	%	-	-	-	-	-	-	0.00	0.02	0.02	0.02	0.03	0.03	0.02	0.02	0.01	0.02	0.05
Thermal coal	%	-	-	-	-	-	-	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.01
Cobalt	%	-	-	-	-	-	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Copper	%	-	-	-	0.05	0.06	0.10	0.09	0.07	0.05	0.06	0.07	0.07	0.07	0.07	0.06	0.06	0.08
Ferroalloys Manganese	%	0.05	0.04	0.05	0.09	0.04	0.02	0.03	0.08	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00
Gold	%	0.01	0.01	0.00	-	-	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.01	0.02	0.03	0.02
Iron Ore	%	0.15	0.15	0.16	0.21	0.38	0.31	0.34	0.60	0.60	1.13	1.41	1.05	1.10	0.64	0.35	0.47	0.55
Iron ore pellets	%	0.04	0.04	0.04	0.08	0.15	0.07	0.09	0.18	0.05	0.27	0.30	0.22	0.20	0.18	0.11	0.11	0.18
Managnese	%	0.11	0.11	0.09	0.04	0.02	0.00	0.00	0.02	0.01	0.01	0.00	0.01	0.01	0.01	0.00	0.01	0.01
Nickel	%	-	-	-	-	-	0.64	0.75	0.21	0.11	0.12	0.13	0.09	0.07	0.11	0.09	0.06	0.05
Platinum	%	-	-	-	-	-	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.00
Palladium	%	-	-	-	-	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01
Phosphate	%	-	-	-	-	-	-	-	-	-	0.02	0.05	0.11	0.07	0.06	0.08	0.06	-
Potash	%	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.02	0.03	0.01	0.01	0.01	0.01	0.00	-	-	-
Kaoline	%	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	-	-	-	-	-	-	-	-
Basket price index weighted by sales		**0.39**	**0.41**	**0.44**	**0.55**	**0.73**	**1.24**	**1.38**	**1.30**	**0.98**	**1.68**	**2.04**	**1.62**	**1.58**	**1.14**	**0.74**	**0.81**	**1.00**

Appendix 11.33: First Quantum economic data - part one

(Source: First Quantum, 2001 - 2017)

Description	Units	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total / Average
US$ inflation index		1.03	1.04	1.07	1.10	1.13	1.17	1.20	1.25	1.25	1.27	1.31	1.33	1.35	1.37	1.38	1.39	1.42	
Year-end open capital commitments $ millions	$ millions	25	28	40	43	45	96	81	216	113	280	380	897	2 309	1 092	714	564	628	**7 551**
Capital expenditure	$ millions	23	28	40	206	190	646	325	768	304	358	1 109	1 317	2 601	2 457	1 565	1 141	1 652	**14 729**
Capital expenditure (real 2000 terms)	$ millions	22	27	38	188	168	552	270	614	244	282	849	988	1 923	1 787	1 137	819	1 161	**11 067**
Capital expenditure as % of revenue	%	16%	55%	67%	182%	43%	59%	21%	44%	16%	15%	43%	45%	73%	69%	62%	43%	50%	**53.1%**
Capital expenditure as % of operational costs	%	18%	57%	91%	349%	110%	191%	50%	80%	33%	24%	67%	53%	79%	70%	47%	35%	39%	**82.1%**
Net cash outflow from acquisition	$ millions	-	-	-	1	-	28	283	305	-	19	-	46	1 063	9	-	-	217	**1 970**
Acquisitions as % of revenue	%	0%	0%	0%	1%	0%	3%	18%	18%	0%	1%	0%	2%	30%	0%	0%	0%	7%	**4.6%**
Net cash inflow from disposals	$ millions	-	-	0	-	-	-	-	-	19	511	-	1 218	2 055	12	-	728	-	**4 543**
Net cash from acquisitions plus disposals	$ millions	-	-	-0	1	-	28	283	305	-19	-492	-	-1 172	-993	-3	-	-728	217	**-2 573**
Net acquistion and disposal cash flow plus capital	$ millions	23	28	40	207	190	674	608	1 073	304	376	1 109	1 363	3 664	2 466	1 565	1 141	1 869	**16 699**
Net cash used in investing activities	**$ millions**	**23**	**28**	**40**	**207**	**190**	**674**	**608**	**1 073**	**304**	**376**	**1 109**	**1 363**	**3 664**	**2 466**	**1 565**	**1 141**	**1 869**	**16 699**
Net cash used in investing activities (real 2000 terms)	**$ millions**	**22**	**27**	**38**	**189**	**168**	**575**	**505**	**858**	**244**	**297**	**849**	**1 022**	**2 708**	**1 794**	**1 137**	**819**	**1 313**	**12 565**
Net cash used in investing activities as % of	**%**	**18%**	**60%**	**97%**	**385%**	**125%**	**233%**	**112%**	**141%**	**41%**	**32%**	**87%**	**74%**	**151%**	**97%**	**65%**	**49%**	**63%**	**107.7%**
New capital commitments $ millions	$ millions	23	31	52	209	192	697	310	903	201	524	1 209	1 834	4 012	1 241	1 187	991	1 716	**15 332**
New capital commitments (real 2000 terms)	$ millions	22	30	49	191	169	595	257	722	161	414	926	1 375	2 966	902	862	711	1 206	**11 560**
New capital commitments as % of operational	%	18%	66%	127%	389%	126%	241%	57%	118%	27%	44%	95%	99%	166%	49%	49%	42%	58%	**104%**
Revenue	$ millions	138	51	60	114	445	1 094	1 539	1 740	1 864	2 378	2 584	2 950	3 553	3 542	2 511	2 673	3 310	**30 547**
Revenue (real 2000 terms)	$ millions	134	49	57	103	392	935	1 278	1 392	1 496	1 878	1 978	2 213	2 626	2 576	1 824	1 918	2 326	**23 176**
Operational costs	$ millions	124	47	41	54	152	289	544	763	745	1 182	1 276	1 849	2 419	2 544	2 405	2 334	2 975	**19 743**
Operational costs (real 2000 terms)	$ millions	121	45	39	49	134	247	452	610	598	933	976	1 387	1 788	1 850	1 747	1 675	2 091	**14 742**
Operational costs as % of revenue	%	90%	92%	68%	47%	34%	26%	35%	44%	40%	50%	49%	63%	68%	72%	96%	87%	90%	**61.9%**
Total capital (Sum of shareholders equity, and net debt)	$ millions	65	72	114	372	546	1 230	1 947	1 791	2 677	2 913	3 739	5 728	12 042	14 895	14 521	14 058	15 057	**91 768**
Shareholders equity	$ millions	45	52	82	158	311	935	1 586	1 401	2 486	2 751	3 676	5 331	7 968	8 913	9 568	9 194	8 960	**63 416**
Shareholders equity (real terms 2000)	$ millions	44	50	76	144	275	799	1 317	1 120	1 995	2 173	2 814	3 998	5 890	6 483	6 951	6 596	6 296	**14390%**
Net debt	$ millions	20	20	32	215	235	295	361	391	192	162	63	397	4 073	5 982	4 953	4 864	6 097	**1 668**
Gearing ratio	%	44%	39%	40%	136%	75%	32%	23%	28%	8%	6%	2%	7%	51%	67%	52%	53%	68%	**42.9%**
New capital commitments as % of total capital	%	35.0%	43.2%	45.8%	56.2%	35.1%	56.7%	15.9%	50.4%	7.5%	18.0%	32.3%	32.0%	33.3%	8.3%	8.2%	7.0%	11.4%	**29.2%**
New capital commitments as % of turnover	%	16.5%	61.1%	86.5%	184.2%	43.2%	63.7%	20.1%	51.9%	10.8%	22.1%	46.8%	62.1%	112.9%	35.0%	47.3%	37.1%	51.8%	**56.1%**
Capital expenditure as percentage of total capital	%	35.0%	39.1%	35.3%	55.4%	34.8%	52.5%	16.7%	42.9%	11.4%	12.3%	29.7%	23.0%	21.6%	16.5%	10.8%	8.1%	11.0%	**26.8%**

Appendix 11.34: First Quantum economic data - part two

(Source: First Quantum, 2001 - 2017)

Description	Units	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total / Average
Profit before tax and special items	$ millions	14	4	6	37	219	647	835	391	748	440	1 120	2 189	899	852	-84	267	60	**8 644**
Profit after tax	$ millions	-21	-3	5	28	153	414	520	46	548	-54	655	1 869	530	993	-610	-19	-239	**4 814**
Net cash inflows from operating activities	$ millions	7	4	17	31	202	474	540	765	563	803	412	343	869	744	1 191	923	914	**8 801**
Net cash inflows from operating activities as % of	%	5%	8%	28%	27%	45%	43%	35%	44%	30%	34%	16%	12%	24%	21%	47%	35%	28%	**28.4%**
Net cash inflows from operating activities and	%	5%	9%	30%	30%	51%	51%	42%	55%	39%	70%	21%	71%	111%	29%	65%	86%	39%	**47.3%**
Net cash inflow to net debt ratio	%	33%	21%	52%	14%	86%	161%	150%	196%	294%	496%	652%	86%	21%	12%	24%	19%	15%	**137.2%**
Impairment charges	$ millions	-	-	-	-	-	-	-	-254	-	-1 239	-	-	-21	-16	-190	-13	-26	**-1 758**
EBITDA	$ millions	-2	4	15	51	275	736	945	536	970	615	1 232	2 361	1 352	1 417	773	964	1 154	**13 398**
EBITDA (real 2000 terms)	$ millions	-2	4	14	47	242	629	785	429	778	485	943	1 771	999	1 031	562	692	811	**10 220**
EBITDA as % of revenue	%	-1%	8%	25%	45%	62%	67%	61%	31%	52%	26%	48%	80%	38%	40%	31%	36%	35%	**40.2%**
Income Taxes	$ millions	-	-	1	11	46	167	183	247	200	495	461	328	370	-141	531	19	299	**3 216**
NOPAT	$ millions	-2	4	14	40	229	569	762	289	770	120	771	2 033	982	1 558	242	945	855	**10 182**
Sales	$ millions	138	51	60	114	445	1 094	1 539	1 740	1 864	2 378	2 584	2 950	3 553	3 542	2 511	2 673	3 310	**30 547**
NOPAT/ Sales	%	-1%	8%	23%	35%	52%	52%	49%	17%	41%	5%	30%	69%	28%	44%	10%	35%	26%	**30.7%**
Dividends paid to shareholders	$ millions	-	-	-	-	4	20	52	53	6	56	90	130	127	181	41	7	5	**772**
Dividends paid as % of net earnings after tax	%	0%	0%	0%	0%	3%	5%	10%	115%	1%	-102%	14%	7%	24%	18%	-7%	-37%	-2%	**2.9%**
Total distribution to shareholders as % of revenue	%	0%	0%	0%	0%	1%	2%	3%	3%	0%	2%	3%	4%	4%	5.1%	2%	0%	0%	**1.8%**
Total distribution to shareholders as % of total assets	%	0.0%	0.0%	0.0%	0.0%	0.5%	1.2%	1.9%	1.8%	0.1%	1.1%	1.7%	1.7%	0.8%	1.0%	0.22%	0.04%	0.02%	**0.7%**
Invested capital	$ millions	141	141	141	424	647	1 530	2 427	2 498	3 917	4 434	4 724	7 142	14 712	17 180	17 910	18 175	20 465	**116 608**
Invested capital less cash	$ millions	117	116	115	374	564	1 281	2 227	2 322	2 998	3 089	4 272	6 833	14 018	16 823	17 545	16 712	19 169	**108 575**
Sales/ Invested capital	%	98%	36%	43%	27%	69%	72%	63%	70%	48%	54%	55%	41%	24%	21%	14%	15%	16%	**44.9%**
ROCE	%	-16.7%	-2.7%	5.8%	10.1%	40.5%	46.2%	36.7%	17.9%	21.1%	11.6%	24.0%	30.9%	6.5%	5%	1%	2%	1%	**14.2%**
ROIC	%	-1.4%	3.1%	9.7%	9.5%	35.4%	37.2%	31.4%	11.6%	19.6%	2.7%	16.3%	28.5%	6.7%	9.1%	1.4%	5.2%	4.2%	**13.5%**
Capital allocated to investment as % of opex * commodity price index (CIPCI)		0.08	0.21	0.38	2.19	1.01	3.08	1.49	1.38	0.40	0.45	1.41	1.03	1.87	1.12	0.61	0.44	0.57	**1.04**

Appendix 11.35: First Quantum ROIC and ROCE calculation

(Source: First Quantum, 2001 - 2017)

Description	**Unit**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
ROIC Calculation																		
Net working capital	**$ millions**	**27**	**27**	**27**	**57**	**134**	**351**	**480**	**225**	**1 196**	**1 355**	**800**	**1 439**	**1 784**	**1 817**	**1 449**	**1 765**	**2 031**
Total current assets	$ millions	48	48	48	106	234	565	736	731	1 844	2 180	1 374	1 833	2 543	2 461	2 157	3 073	3 189
Non-interest bearing current liabilities	$ millions	-21	-21	-21	-49	-100	-214	-256	-507	-648	-825	-574	-395	-759	-644	-708	-1 308	-1 158
Current liabilities	$ millions	34	34	34	72	158	272	329	646	732	965	622	444	1 805	697	1 094	2 224	2 068
Interest bearing current liabilities	$ millions	13	13	13	23	58	58	74	140	85	141	48	49	1 046	53	386	916	910
Total non-current assets	$ millions	115	115	115	367	512	1 180	1 947	2 273	2 721	3 079	3 924	5 703	12 928	15 363	16 461	16 410	18 434
Invested capital	$ millions	141	141	141	424	647	1 530	2 427	2 498	3 917	4 434	4 724	7 142	14 712	17180	17910	18175	20465
Cash or cash equivalents	$ millions	24	25	26	50	83	250	200	176	919	1 345	452	309	695	357	365	1 463	1 296
Invested capital excluding cash	$ millions	117	116	115	374	564	1 281	2 227	2 322	2 998	3 089	4 272	6 833	14 018	16 823	17 545	16 712	19 169
Return on invested capital (ROIC)	%	-1%	3%	10%	10%	35%	37%	31%	12%	20%	3%	16%	28%	7%	9%	1%	5%	4%
ROCE Calculation																		
EBIT	$ millions	-21	-3	7	40	238	680	863	423	808	499	1 120	2 189	895	845	211	278	260
EBITDA	$ millions	-2	4	15	51	275	736	945	536	970	615	1 232	2 361	1 352	1 417	773	964	1 154
less depreciation and amortisiation	$ millions	-19	-8	-8	-11	-37	-56	-81	-113	-162	-116	-112	-172	-457	-572	-562	-686	-894
Total assets	$ millions	162	162	162	473	747	1 744	2 683	3 005	4 565	5 259	5 298	7 536	15 471	17 824	18 618	19 483	21 623
Current liabilities	$ millions	34	34	34	72	158	272	329	646	732	965	622	444	1 805	697	1 094	2 224	2 068
Capital employed	$ millions	128	128	128	401	588	1 473	2 353	2 359	3 832	4 293	4 676	7 093	13 666	17 127	17 524	17 259	19 555
Return on capital employed (ROCE)	%	-17%	-3%	6%	10%	40%	46%	37%	18%	21%	12%	24%	31%	7%	5%	1%	2%	1%

Appendix 11.36: First Quantum production and commodity prices - part one

(Source: First Quantum, 2001 - 2017)

Description	Units	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Average
Rand/US$ Exchange Rate		8.62	10.48	7.55	6.44	6.37	6.77	7.05	8.27	8.41	7.32	7.26	8.21	9.65	10.85	12.78	14.7	13.31	**9.06**
Sterling/US$ Exchange Rate		0.69	0.67	0.61	0.55	0.55	0.54	0.5	0.54	0.64	0.65	0.62	0.63	0.64	0.61	0.65	0.74	0.78	**0.62**
Euro/US$ Exchange Rate		1.12	1.06	0.88	0.8	0.8	0.8	0.73	0.68	0.72	0.75	0.72	0.78	0.75	0.75	0.9	0.9	0.89	**0.83**
Australian Dollar/US$ Exchange Rate		1.93	1.84	1.53	1.36	1.31	1.33	1.19	1.17	1.26	1.09	0.97	0.97	1.03	1.11	1.33	1.34	1.3	**1.30**
Chilean Peso/US$ Exchange Rate				690	609	559	530	522	524	559	510	484	486	495	571	655	676	649	**568**
Brazilian real									1.84	2	1.76	1.67	1.95	2.16	2.35	3.34	3.48	3.19	**2.37**
US CPI Inflation		2.8%	1.6%	2.3%	2.7%	3.4%	3.2%	2.8%	3.8%	-0.4%	1.6%	3.2%	2.1%	1.5%	1.6%	0.1%	1.3%	2.1%	
US CPI Index		1.03	1.04	1.07	1.10	1.13	1.17	1.20	1.25	1.25	1.27	1.31	1.33	1.35	1.37	1.38	1.39	1.42	
Commodity Prices (Nominal)																			
Cobalt	US$/tonne	15 400	13 200	18 000	23 000	33 000	32 915	54 146	66 000	22 000	33 268	34 458	27 051	24 141	23 523	21 936	24 273	51 513	**30 460**
Copper	US$/tonne	1 808	1 433	1 653	2 491	3 660	6 217	6 548	4 894	4 762	7 165	8 532	7 738	7 099	6 680	5 357	4 982	5 137	**5 068**
Gold	US$/oz	272	310	363	409	445	603	695	872	972	1 125	1 572	1 669	1 411	1 266	1 160	1 250	1 257	**921**
Nickel	US$/tonne	5 886	6 768	9 634	13 845	14 727	31 982	37 442	21 010	14 596	21 980	22 680	17 549	15 036	16 711	11 420	9 370	10 296	**16 525**
Platinum	US$/tonne	531	541	692	847	897	1 142	1 304	1 585	1 211	1 610	1 725	1 555	1 487	1 385	1 051	989	950	**1 147**
Palladium	US$/oz	597	336	201	231	201	321	355	355	266	527	736	647	725	803	691	615	871	**499**
Zinc	US$/tonne	904	772	838	1 058	1 389	3 263	3 241	1 874	1 653	2 161	1 644	1 538	1 494	1 351	1 622	1 154	1 917	**1 667**
Commodity Prices (Real 2000 Prices)																			
Cobalt	US$/tonne	14 974	12 636	16 849	20 967	29 097	28 115	44 969	52 787	17 658	26 272	26 379	20 289	17 845	17 111	15 937	17 415	36 199	**24 441**
Copper	US$/tonne	1 758	1 372	1 548	2 271	3 227	5 310	5 438	3 914	3 822	5 658	6 532	5 804	5 247	4 859	3 892	3 575	3 610	**3 990**
Gold	US$/oz	264	297	340	373	392	515	577	697	780	888	1 203	1 252	1 043	921	843	897	883	**716**
Nickel	US$/tonne	5 723	6 479	9 018	12 621	12 985	27 318	31 096	16 804	11 716	17 358	17 362	13 162	11 114	12 155	8 297	6 722	7 235	**13 363**
Platinum	US$/tonne	516	518	648	772	791	975	1 083	1 268	972	1 271	1 321	1 166	1 099	1 007	764	710	668	**915**
Palladium	US$/oz	580	322	188	211	177	274	295	284	214	416	563	485	536	584	502	441	612	**393**
Zinc	US$/tonne	879	739	784	965	1 225	2 787	2 692	1 499	1 327	1 706	1 259	1 153	1 104	983	1 179	828	1 347	**1 446**

Appendix 11.37: First Quantum production and commodity prices - part two

(Source: First Quantum, 2001 - 2017)

Description	Units	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Average
Production Volumes																			
Cobalt	tonnes (000)	0	0	0	0	0	0	0	0	0	0	0	0.3	0.5	0.9	0.8	0.6	0.5	**0.6**
Copper	tonnes (000)	50	12	30	42	119	183	226	334	374	323	266	307	412	428	428	539	574	**273**
Gold	troy oz (000)	0	0	0	0	14	33	108	116	193	191	175	202	248	230	224	214	200	**165**
Nickel	tonnes (000)	0	0	0	0	0	0	0	0	0	0	6	37	47	46	35	24	18	**30**
Platinum	troy oz (000)	0	0	0	0	0	0	0	0	0	0	0	14	30	34	32	13	0	**25**
Palladium	troy oz (000)	0	0	0	0	0	0	0	0	0	0	0	12	25	26	25	10	0	**20**
Zinc	tonnes (000)	0	0	0	0	0	0	0	0	0	0	0	0	43	36	20	29	21	**30**
Sales revenue - Nominal																			
Cobalt	$ million	0	0	0	0	0	0	0	0	0	0	0	7	9	15	12	10	17	**12**
Copper	$ million	91	17	49	104	436	1139	1482	1637	1781	2314	2266	2377	2927	2857	2294	2688	2948	**1 612**
Gold	$ million	0	0	0	0	6	20	75	101	188	215	275	337	350	291	260	268	251	**203**
Nickel	$ million	0	0	0	0	0	0	0	0	0	0	129	645	708	767	405	221	184	**437**
Platinum	$ million	0	0	0	0	0	0	0	0	0	0	0	21	45	47	34	13	0	**32**
Palladium	$ million	0	0	0	0	0	0	0	0	0	0	0	8	18	21	17	6	0	**14**
Zinc	$ million	0	0	0	0	0	0	0	0	0	0	0	0	64	49	32	33	40	**44**
Total		**91**	**17**	**49**	**104**	**442**	**1 160**	**1 557**	**1 738**	**1 969**	**2 530**	**2 670**	**3 395**	**4 121**	**4 046**	**3 054**	**3 239**	**3 440**	**1 978**
Pearson correlation coefficient - sales and price		**0.66**																	
Sales revenue - Real Terms 2000																			
Cobalt	$ million	-	-	-	-	-	-	-	-	-	-	-	5	7	11	9	7	12	**8**
Copper	$ million	89	16	46	94	384	973	1 230	1 309	1 429	1 828	1 735	1 782	2 163	2 078	1 667	1 928	2 072	**1 225**
Gold	$ million	-	-	-	-	6	17	62	81	151	170	211	253	259	212	189	192	176	**152**
Nickel	$ million	-	-	-	-	-	-	-	-	-	-	98	484	523	558	294	159	129	**321**
Platinum	$ million	-	-	-	-	-	-	-	-	-	-	-	16	33	34	24	9	-	**23**
Palladium	$ million	-	-	-	-	-	-	-	-	-	-	-	6	13	15	13	5	-	**10**
Zinc	$ million	-	-	-	-	-	-	-	-	-	-	-	-	48	36	23	24	28	**32**
Total		**89**	**16**	**46**	**94**	**390**	**991**	**1 293**	**1 390**	**1 580**	**1 998**	**2 044**	**2 546**	**3 046**	**2 943**	**2 219**	**2 324**	**2 417**	**1 496**
Pearson correlation coefficient - sales and price		**0.70**																	

Appendix 11.38: First Quantum basket price index calculation

(Source: First Quantum, 2001 - 2017)

Description	Units	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Commodity % Contribution to Total Sales																		
Cobalt	%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Copper	%	100%	100%	100%	100%	99%	98%	95%	94%	90%	91%	85%	70%	71%	71%	75%	83%	86%
Gold	%	0%	0%	0%	0%	1%	2%	5%	6%	10%	9%	10%	10%	8%	7%	9%	8%	7%
Nickel	%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	5%	19%	17%	19%	13%	7%	5%
Platinum	%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%	1%	0%	0%
Palladium	%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	0%	0%
Zinc	%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%	1%	1%	1%	1%
Commodity Price Index (Real Terms)																		
Cobalt	%	61%	52%	69%	86%	119%	115%	184%	216%	72%	107%	108%	83%	73%	70%	65%	71%	148%
Copper	%	44%	34%	39%	57%	81%	133%	136%	98%	96%	142%	164%	145%	132%	122%	98%	90%	90%
Gold	%	37%	41%	47%	52%	55%	72%	81%	97%	109%	124%	168%	175%	146%	129%	118%	125%	123%
Nickel	%	43%	48%	67%	94%	97%	204%	233%	126%	88%	130%	130%	98%	83%	91%	62%	50%	54%
Platinum	%	56%	57%	71%	84%	86%	107%	118%	139%	106%	139%	144%	128%	120%	110%	83%	78%	73%
Palladium	%	148%	82%	48%	54%	45%	70%	75%	72%	54%	106%	143%	123%	136%	149%	128%	112%	156%
Zinc	%	61%	51%	54%	67%	85%	193%	186%	104%	92%	118%	87%	80%	76%	68%	82%	57%	93%
Commodity Price Index Weighted by Sales																		
Cobalt	%	-	-	-	-	-	-	-	-	-	-	-	0.00	0.00	0.00	0.00	0.00	0.01
Copper	%	0.44	0.34	0.39	0.57	0.80	1.31	1.30	0.92	0.87	1.30	1.39	1.02	0.93	0.86	0.73	0.74	0.78
Gold	%	-	-	-	-	0.01	0.01	0.04	0.06	0.10	0.11	0.17	0.17	0.12	0.09	0.10	0.10	0.09
Nickel	%	-	-	-	-	-	-	-	-	-	-	0.06	0.19	0.14	0.17	0.08	0.03	0.03
Platinum	%	-	-	-	-	-	-	-	-	-	-	-	0.01	0.01	0.01	0.01	0.00	-
Palladium	%	-	-	-	-	-	-	-	-	-	-	-	0.00	0.01	0.01	0.01	0.00	-
Zinc	%	-	-	-	-	-	-	-	-	-	-	-	-	0.01	0.01	0.01	0.01	0.01
Basket price index weighted by sales		**0.44**	**0.34**	**0.39**	**0.57**	**0.80**	**1.32**	**1.34**	**0.98**	**0.97**	**1.40**	**1.63**	**1.39**	**1.23**	**1.16**	**0.94**	**0.89**	**0.91**