School of Mining Engineering

UNIVERSITY OF THE
WITWATERSRAND,
JOHANNESBURG

# MERGERS AND ACQUISITIONS BY SOUTH AFRICAN MINING COMPANIES AS A STRATEGY TO CREATE VALUE FOR SHAREHOLDERS: EVIDENCE BETWEEN 1998 AND 2022

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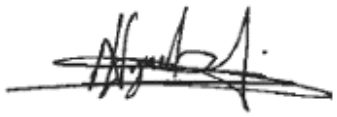
A research dissertation submitted to the Faculty of Engineering and the Built Environment, University of the Witwatersrand, Johannesburg, in fulfilment of the requirements for the degree of Master of Science in Engineering.

Johannesburg, 2025

## DECLARATION

I declare that this research dissertation is my own unaided work. It is being submitted for the degree of Master of Science at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination to any other university.

I have familiarised myself with the University of the Witwatersrand Student Academic Misconduct Policy (SAMP). I hereby declare that the work I am submitting for assessment is my original work. I affirm that I have not plagiarised, misrepresented, or colluded with any other person or source. I have properly acknowledged, cited, and referenced all the sources that I have used in my work. I also declare that I have used artificial intelligence (AI) tools only as a means of guidance. The ideas and arguments presented in my work are my original thoughts and interpretations. I acknowledge that any academic misconduct, such as plagiarism or collusion will result in serious consequences. These consequences may include a reduced grade, a fail mark, or disciplinary action according to the SAMP. The School of Mining Engineering has my consent to investigate any potential academic misconduct in my work. This investigation may include the use of similarity and AI detection software to check the originality of my work. I undertake to abide by the decision of any such investigation.



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10th day of May, 2025

## ABSTRACT

The objective of this study was to determine if acquiring of assets by mining companies has been beneficial to the shareholders from 1998 to 2022. This study seeks to answer the null hypothesis stating that transaction announcement does not create cumulative average abnormal return for buying mining companies and does not create value for shareholders.

Data for the study was acquired from Standards and Poor's database and streamlined down to 41 transactions. The samples were then grouped into full sample, diversified metal and mining, gold, precious metals, steel, and 1998 to 2022 five year periods sample grouping. This quantitative research uses an event study that serves as a statistical method to evaluate the influence an event has over the value of a company. The event window includes buying company share price starting at 250-days preceding the announcement date and 10 days after. Then, 21 days (-10, 0, 10), was strategically chosen to capture results 10 days before and after the event announcement. This method allows the computation of average abnormal returns and cumulative average abnormal returns. The results are presented using a structure that includes: sample descriptive statistics, average abnormal returns and cumulative average abnormal returns, cumulative average abnormal returns weighted, solver (to minimise sample variance), correlation, covariance and efficient frontier (to plot a graph which conservative to aggressive investors can extract return on investment).

All samples cumulative average abnormal returns were plotted on a graph and on average, it reduces leading up to event day and increases after the event day. The null hypothesis was accepted across all sample groups and the study outcomes indicate that acquirers did not generate statistically significant positive abnormal returns. An opportunity exists for researchers to research gold companies and the value created using a long-term event study methodology.

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# LIST OF ABBREVIATIONS

Column A and B below represent Abbreviations and Description respectively.

| A | B | A | B |
|---|---|---|---|
| AAL | Anglo American Limited | JSELBEEB | JSE Listed BEE Buyers |
| AAR | Average Abnormal Return | KOSE | Korea Stock Exchange |
| ACX | Acerinox, S.A | KZG | Kazera Global plc |
| AIM | Alternative Investment Market | LP | Linear Programing |
| APT | Arbitrage Pricing Theory | LSE | London Stock Exchange |
| AR | Abnormal Returns | M&A | Mergers and Acquisitions |
| ARM | African Rainbow Minerals | M&R | Murray and Roberts |
| ASX | Australian Stock Exchange | MCM | MC Mining (MC meaning unknown) |
| ATC | ATC (Pty) Limited | mill | million |
| BEE | Black Economic Empowerment | bill | billion |
| BME | Brazil Stock Exchange | MPT | Modern Portfolio Theory |
| BMI | Broad Market Index | MRF | Merafe Resources Limited |
| CAAR | Cumulative Average Abnormal Return | MRH | Mining Right Holder |
| CAPM | Capital Asset Pricing Model | NPH | Northam Platinum Holdings |
| CAR | Cumulative Abnormal Returns | NPV | Net Present Value |
| CEO | Chief Executive Officer | NYSE | New York Stock Exchange |
| CML | Capital Market Line | OLS | Ordinary Least Squares |
| $CO_2$ | Carbon Dioxide | ORN | Orion Minerals |
| CRSP | Centre for Research in Security Prices | ORR | Oriole Resources PLC |
| D/E | Debt to Equity Ratio | P/E | Price Earnings Ratio |
| DMM | Diversified Metals and Mining | PDL | Petra Diamonds Limited |
| DMRE | Department of Mineral Resources and Energy | PGM | Platinum Group Metals |
| DPS | Dividends Per Share | PMM | Precious Metals and Minerals |
| DRD | DRDGold imited | POSCO | Formerly - Pohang Iron and Steel Company |
| EF | Efficient Frontier | PTM | Platinum Group Metals Ltd |
| ELR | Eastern Platinum Limited | PwC | Pricewaterhouse Coopers |
| EPS | Earnings Per Share | RBX | Raubex Group Limited |

| A | B | A | B |
|---|---|---|---|
| ESKOM | SA Power Utility | RNG | Randgold & Exploration Company Limited |
| FTSE/JSE | Benchmark administrator of index series | ROA | Return on Assets |
| GFI | Gold Fields Limited | ROE | Return on Equity |
| GG | Galane Gold Ltd. | ROI | Return on Investment |
| GRG | Generalized Reduced Gradient | S&P | Standard and Poor's |
| HAR | Harmony Gold Mining Company Limited | SA | South Africa |
| HDSA | Historically Disadvantaged South African | THA | Tharisa Plc |
| IMAA | Institute for Mergers, Acquisitions and Alliances | TSE | Tokyo Stock Exchange |
| IMF | International Monetary Fund | TSX | Toronto Stock Exchange |
| INL | Investec Group | TV | Transaction Value |
| JLP | Jubilee Metals Group PLC | | |
| JSE | Johannesburg Stock Exchange | US$ | United States of American Dollar |
| RLO | Reunert Limited | WP | Window Period |

# 1 INTRODUCTION

## 1.1 Scope of the Study

The purpose of the study was to research whether mining mergers and acquisition (M&A) deals that took place between 1998 and 2022 in the mining industry, have been beneficial to shareholders. The overall aim of this research was to put together a framework that can assist mining companies in concluding M&A transactions that would create value for shareholders. Transactions involve an acquiring company A buying a target company B.

## 1.2 Research Background

Mining companies in South Africa (SA) deploy different strategies to grow and one of the ways was by the use of M&As. Growth was vital in sustaining the value-enhancing capability of a company or corporate entity.

An entity can create value by entering into a new customer base or by expanding existing customers. This can happen if, for example, a company was not growing due to lack of innovation its product or service offering. A company can create outward value through M&A (Aluko & Amidu, 2005). SA companies use the M&A strategy as shown in Figure 1-1, from the Institute for Mergers, Acquisition and Alliance (IMAA). The figure shows all industries' M&A transactions in SA that took place from 1998 to 2022.

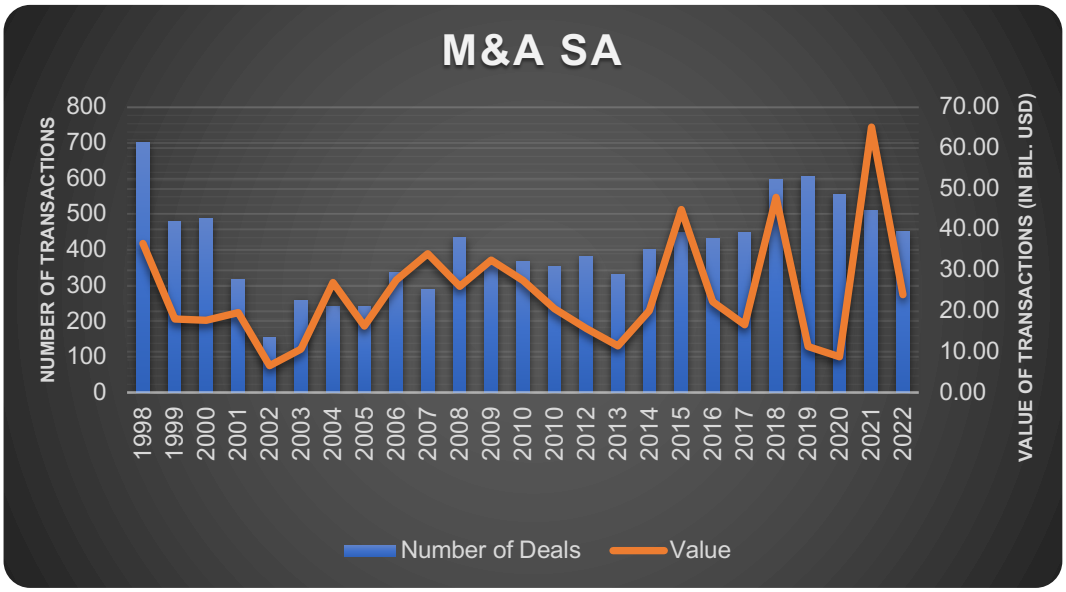


*Figure 1-1: M&A in South Africa: 1998 to 2022 (Institute for Mergers, Acquisition and Alliance, 2023)*

The year 1998 was the year with the highest number of transactions with deals involving Anglo American Limited being the top mining transactions. The transactions dropped and started picking up from below 200 in year 2002, a 1 was introduced in SA. After the peak in 2008, number of transactions averaged above 300 until 2014. The year 2014 was also a period of Department of Mineral Resources and Energy (DMRE) Mining Charter deadline for mining companies to comply with the minimum target of 26% BEE shareholding (DMRE, 2010). This target was in accordance with the 2010 Mining Charter. The years 2018 and 2019 recorded 600 number of transactions each, which was 100 transactions short of 1998 peak respectively. The current Mining Charter which came into effect in 2018, required mining rights to have a minimum 30% BEE shareholding (DMRE, 2018). The influence of this minimum target can be expected to be evident on the mining transactions sample population from 2018 to 2022. Transactions hit a record value of above $65,14bill (billion) in year 2021 during the Covid-19 pandemic period.

**Shareholder Value**:

Several studies have researched M&A and demonstrated a positive impact on shareholder value, with the majority of benefits being realised by the owners of the acquiree companies (Andrade *et al*., 2001). Alternatively, owners of bidding entities often experience growth dilution following the merger by losing as much as 10% of their investment, as discovered by some researchers (Agrawal *et al*.,1992).

## 1.3 Problem Statement

The body of M&A knowledge has yielded insights on the reasons why companies participate in M&A transactions to address the problem of adding value to shareholders. Some of the insights include:

- **Diversification dilutes value whereas focus was the alternative**: Diversification, on average, results in a loss of value ranging between 13 and 15 percent. The level of relatedness between the businesses of the buyer and seller was positively linked to returns. Deals involving conglomerates, characterised by firms with unrelated lines of business, tend to yield the poorest returns. Diversifying (unrelated) mergers typically underperform compared to companies in the same line of business. Buyers in conglomerate deals suffered negative, albeit insignificant returns, while non-conglomerate deals were associated with positive and significant returns for buyers. Mergers focusing on both activity and geography were found to enhance the buyer's share value by 2 to 3 percent more than other types of mergers (Bruner, 2004).
- **Anticipated synergies**: buying and target companies may execute an M&A to archive operational, financial and economies of scale (Osae et al., 2011).
- **M&A to increase market power creates value destruction**: Attempts to improve market position through M&A endeavours do not consistently result in improved performance; in some cases, such attempt may even lead to worse outcomes. The fluctuations in the

share prices of competitive rivals do not consistently align with the notion of increased market power by the acquiring companies (Bruner, 2004).

- **Paying with cash adds value and paying with stocks is expensive**: Announcements of stock-based deals are linked to notably negative returns, while cash deals exhibit neutral or slightly positive reactions (Bruner, 2004).
- **Regulations that impact M&A transactions are expensive to investors**: evidence was found suggesting that regulation can benefit companies that are competitors to buying and target companies, returns of buying and target firms were significantly higher than after implementation of a regulation (Bruner, 2004). Other regulations such as BEE policy and Mining Charter promotes compliance which may dilute or add value to shareholders.
- **Reinvesting excess cash through M&A destroys value in most cases**: Companies with large cash reserves face the decision of either returning the cash to investors through dividends or reinvesting it in activities such as M&A. Bruner (2004) found that the announcement of M&A transactions by cash-rich firms may lead to value destruction.
- **Tender offers add value to bidding companies**: Tender offers are presented in the form of take-it-or-leave-it proposals directly to the shareholders of the target firm. Bruner (2004) found that numerous research studies indicate that there are more substantial announcement returns for bidders in tender offers when compared to friendly negotiated transactions (Bruner, 2004); and
- **Buying companies initiating M&A programs**: When companies declare their intention to pursue a series of acquisitions to achieve strategic goals, there was a substantial increase in the stock price of the companies. In general, the rise in share prices result in value creation (Bruner, 2004).

The assessment of the impact of asset unbundling by South African mining companies on shareholder benefits requires a comprehensive analysis of the factors influencing such decisions and their subsequent financial implications. Furthermore, understanding the underlying motivations driving companies to divest profitable assets were essential for constructing a strategic framework that aligns with organizational goals. Additionally, determining the relative success of M&A strategies, specifically comparing diversifying and non-diversifying approaches by mining companies, was a complex challenge that necessitates an in-depth investigation into various performance metrics and industry dynamics. This technical problem statement aims to address the intricate interplay between asset unbundling, corporate motivations, and M&A strategies within the context of South African mining companies to provide valuable insights for effective decision-making and strategy formulation.

## 1.4 Research Questions

The research has addressed the following questions:

- Has the unbundling and acquiring of assets by SA mining companies been beneficial to the shareholders?
- What was the motivation behind the will of companies to let go of profitable assets?
- Which was more of a successful M&A strategy between diversifying versus non-diversifying by mining companies to create value?

## 1.5 Research Motivation

Motivated by the extensive literature review that delves into various facets of M&A, the research aims to contribute valuable insights to the existing body of knowledge. The findings from previous studies have presented a nuanced perspective on the outcomes of M&A activities, ranging from divergent impacts on shareholder value to the influence of relatedness

between businesses involved. The observed trends, such as the negative returns associated with diversification and the positive effects of mergers focusing on both activity and geography, underscore the need for a more comprehensive understanding of the factors influencing M&A success.

This research was prompted by the desire to address critical questions surrounding M&A strategies, such as the effectiveness of diversification versus non-diversification and the motivations behind firms letting go of profitable assets. The conflicting evidence from different studies necessitates a deeper investigation to unravel the complexities of M&A outcomes. Additionally, the examination of factors influencing investor reactions and the evaluation of various payment methods used in M&A transactions add layers of complexity to the overarching research motivation.

Furthermore, the research was driven by the aspiration to provide practical insights for companies engaged in M&A activities, financial analysts, and policymakers. Understanding the dynamics revealed in the literature review can guide strategic decision-making, offering a roadmap for firms considering M&A ventures. By bridging gaps in the current understanding of M&A success determinants, this research aims to contribute valuable knowledge that can inform more effective strategies and policies in the realm of corporate acquisitions.

### 1.6 Research Aim

As the aim of this research was to put together a report that can assist mining companies concluding M&A transactions that would create value for the shareholder and the SA economy,

## 1.7 Research Objectives

The objectives are:

- To determine if the unbundling or acquiring of assets by SA mining companies has been beneficial to the shareholders; from 1998 to 2022;
- Quantify the impact of performance outcomes on the success of various M&As;
- Investigate the correlation existence and test the statistical significance of value created before and after the M&A announcement;
- Outline the M&A success strategy between diversifying versus non-diversifying by mining companies to create value; and
- Recommend on the future of M&A for existing MRH and new entrants into the mining industry

## 1.8 Significance of Research

The significance of this study lies in its contribution to the existing body of knowledge on M&A in the context of South African mining companies. The literature review highlights the complexities and challenges associated with M&A transactions, including factors such as diversification, relatedness between businesses, payment methods, and the impact on shareholder value. By addressing these aspects within the specific context of the South African mining industry, this research seeks to provide valuable insights and fill existing gaps in understanding.

Understanding the implications of the unbundling and acquiring of assets by mining companies, the motivations behind divesting profitable assets, and the effectiveness of different M&A strategies was crucial for stakeholders in

the mining sector. Additionally, the study focus on South Africa adds a specific regional perspective to the broader literature on M&A, considering the unique economic, regulatory, and market conditions in the country.

The findings of this research may have practical implications for mining companies, investors, policymakers, and other industry stakeholders. By identifying patterns, trends, and success factors related to M&A activities in the South African mining sector, the study aims to provide actionable insights that can inform strategic decision-making and contribute to the overall success and sustainability of mining companies in the region.

# 2 LITERATURE REVIEW

## 2.1 Introduction

From 1994, South Africa companies faced significant pressure to comply with the broader principle of empowerment under the banner of BEE. “The release of the draft Mining Charter in October 2002, which first proposed such changes, caused a severe negative reaction in share prices of South African mining companies” (Ward & Muller, 2010, p. 27). While transactions ramped up in the era of BEE from 2002 to 2008 to reach a steady state of an average of 447 transactions year on year for 12 years, minerals sales painted a picture of growth from 2016 to 2022. Figure 2-1 shows the total value of mineral sales from 2016 to 2022.

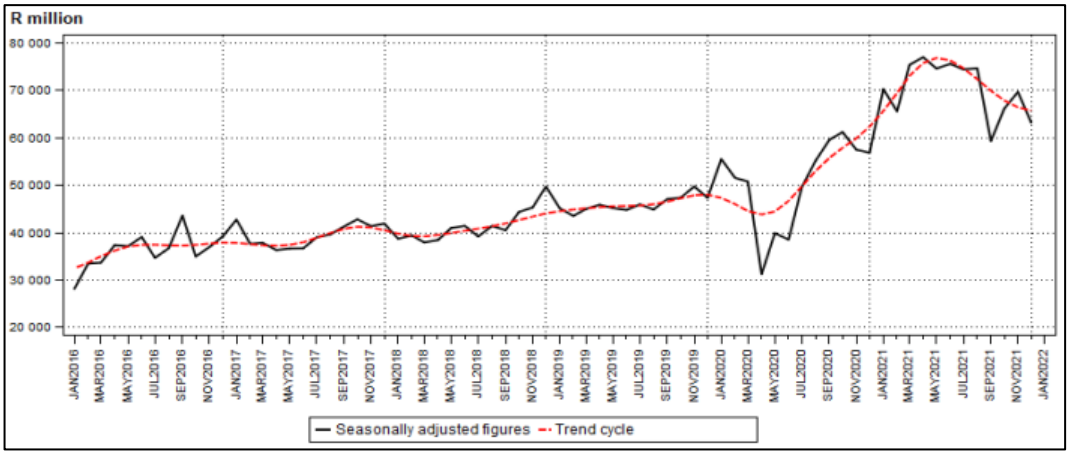


*Figure 2-1: Total value of mineral sales at current prices (Statistics South Africa, 2021).*

The principal minerals which contributed to sales (as shown in Figure 2-1) include platinum group metals, coal, non-metallic minerals and manganese ore. An assumption can be made that shareholders of mining right holders (MRH) have benefited positively in from January 2016 to January 2022 as shown in the upward trend of the chart. Similar charts were not available on Statistic South Africa reports from 1998 to 2015. However, using an index

of mining physical volume base of 100 from 1998 to 2022 (period selected to accommodate large sample of mining transactions), Statistic South Africa reported the following production:

- A decline from 99,3 in 1998 to 96,4 in 2000 (Statistics South Africa, 2001);
- An upward trend cycle from 2001 to 2005 with an index of 93 being the low and a high of 120 (Statistics South Africa, 2005);
- A decline trend cycle from 2005 high of 120 to a low of 80 in 2010 (Statistics South Africa, 2010);
- A horizontal trend cycle from 2011 to 2016 with a low index of 82.5 and a high of 114 (Statistics South Africa, 2016); and
- A horizontal trend cycle from 2017 to 2022 with a low index of 50 and a high of 108 (Statistics South Africa, 2023).

Figure 3 shows ownership by BEE shareholders in 2019.

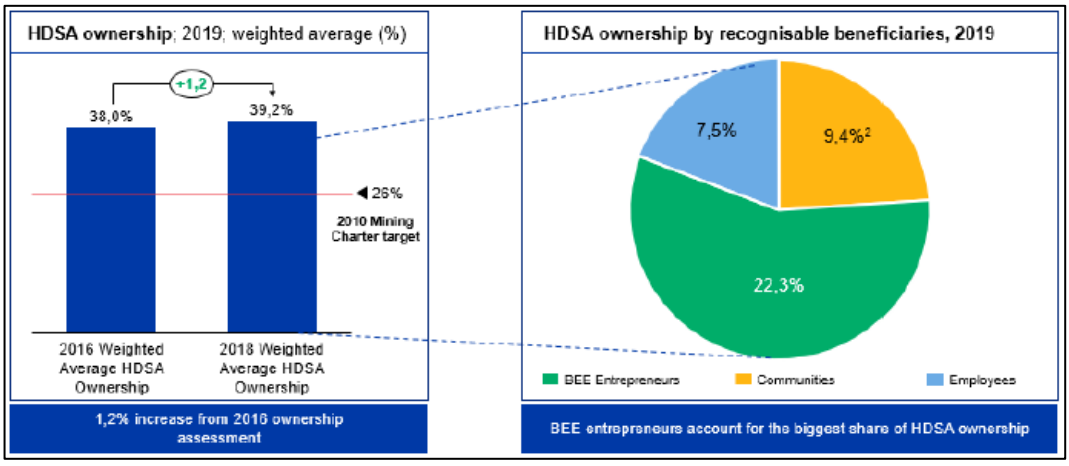


*Figure 2-2: Resource sector BEE ownership (Minerals Council South Africa, 2019).*

While production trend has remained flat for 11 years (2011 to 2022), the Mineral Council South Africa (2019) found that mining in SA has attained almost a 40% BEE ownership rate (Figure 2-2), comprising of 22.3% black entrepreneurs, 7.5% employee stock ownership plans (on grounds of employee turnover) and 9.4% as communities. In comparison to results of the 2016 transformation analysis, historically disadvantaged South Africans (HDSA) ownership grew by 3.2% (to 38.0%). A deeper examination of the individual MRH reveals that 83% of the MRH under analysis (80 out of 93) attained at least 26% HDSA ownership target set in the Mining Charter 2010 BEE ownership (Minerals Council South Africa, 2019).

According to the Mining Charter 2010 (South African Government, 2010), 22 (23.7%) MRH under analysis produced significant industry involvement. Significant industry involvement, which was only included in the 2010 Mining Charter, was attained by meeting below conditions (Minerals Council South Africa, 2019):

- Minimum 26% BEE ownership;
- Shareholders that can be easily identified as BEEs;
- Voting rights; and
- Trickle of cash flow.

Some of the transactions that occurred in SA that have been witnessed took place not to create growth, but to comply with the conditions of Mining Charter, Figure 2-3 shows the MRH sample results.

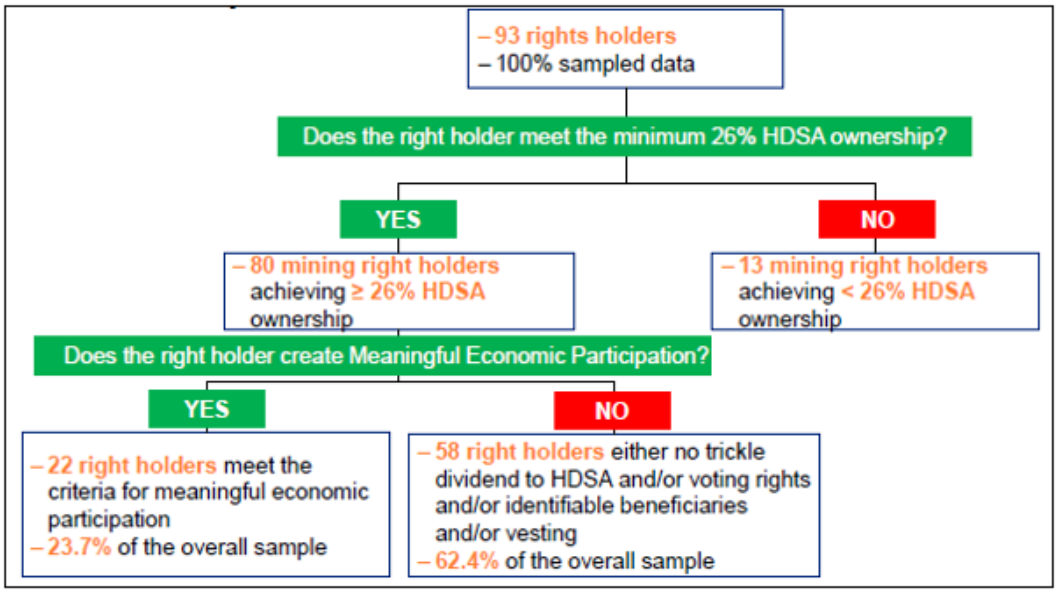


*Figure 2-3: MRH creating meaningful economic value (Minerals Council South Africa, 2019).*

BEE Transactions totalled R159 bill in 2016 (Minerals Council South Africa, 2019). In comparison, the MRH that was sampled by the Mineral Council as shown in Figure 2-3, reduced value down to R132 bill (16.8% negative growth) due to HDSA transactions. When considering the entire sector, 168 BEE transactions totalling R113 bill were carried out in the period beginning in 2002 and ending just before the Mining Charter 2010 was introduced. However, this number substantially decreased, with only 67 BEE transactions totalling R30 bill after 2010 (Minerals Council South Africa, 2019).

### 2.1.1 Mineral Resource Overview

From a mineral standpoint, Figure 2-4 shows BEE shareholders.

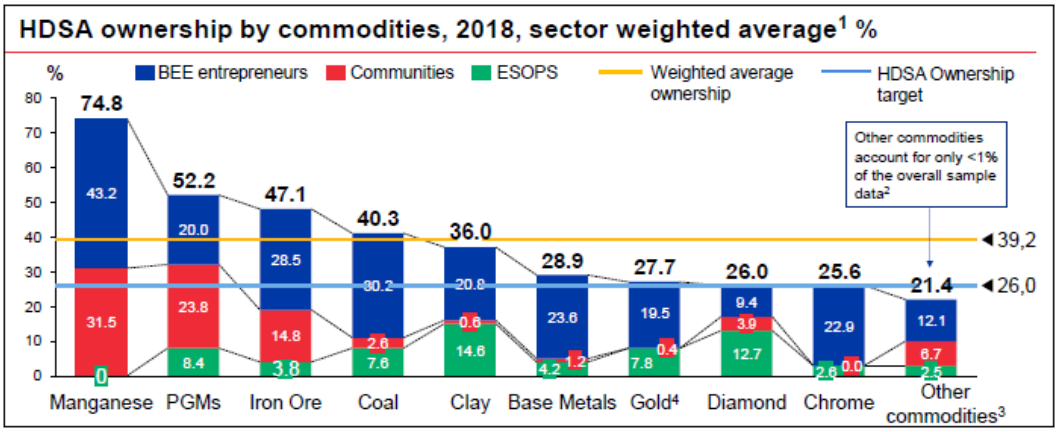


*Figure 2-4: - BEE ownership by different commodities (Minerals Council South Africa, 2019).*

Manganese mines hold the largest BEE equity of 74.8%, whereas BEE ownership for platinum group metals (PGMs) stands at 52.2% and 47.1% for iron ore, calculated using a weighted average for the industry. While all other commodity sectors reach or surpass the 26% Mining Charter 2010 ownership objective, only 21.4% of other resources are controlled by HDSAs. Comparatively to mining communities and employees, BEE entrepreneurs possess most of the stock. As illustrated in Figure 2-4, manganese, PGMs and iron ore are above the 39.2% weighted average BEE ownership (Minerals Council South Africa, 2019).

## 2.2 Agency Theory

Several finance and management acquisition studies have referred to agency theory as a measure of increasing shareholder wealth (Jensen & Meckling, 1976). Haleblian et al., (2009) noted that abnormal returns surrounding M&As in the short-term, continues to gain favour as the method of choice by researchers. The authors observed that cumulative abnormal returns around the dates of acquisition announcements represent the reactions of investors to the announcement of acquirer and target merger, due to current assumptions of predicted cash inflow and outflows of the merged entity.

Many researchers consider that, in an efficient market, ARs are the best way to measure acquisition performance and some research findings have suggested that the market may be able to predict post-acquisition performance (Healy *et al*., 1992). By reducing noise from other potentially confounding variables, one key event study benefit of utilising short windows was that cumulative abnormal returns (CARs) that result from share price movements can be reasonably set down to the M&A announcement. Despite abnormal returns appearing to be the typical way to measure the positive or negative impact of M&A, some authors argue that the measure has flaws. In particular, markets do not have perfect knowledge, even though markets predict future cash flows.

As a result, event study research methodology mostly evaluates the prospective positive AR when the announcement takes place. However, destroyed or created growth was not captured by short-term window studies during the execution of the merger (Haleblian *et al*., 2009).

### 2.3 Antecedents Concepts

Figure 2-5 shows summarised conceptual framework of M&A transactions.

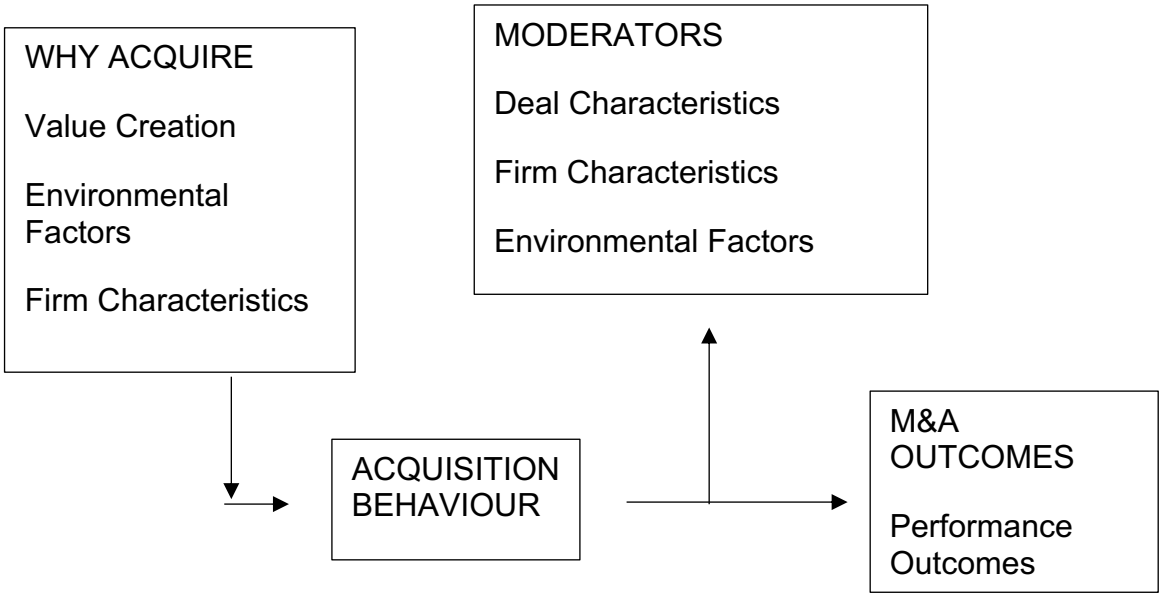


*Figure 2-5: M&A Conceptual Framework (Haleblian et al., 2009).*

Figure 2-5 framework was unpacked as follows:

**Motivation to Acquire:** Why businesses acquire is a central theme in many research studies. Even though many acquisition antecedents have been presented by researchers, acquisitions can be broadly divided as follows (Haleblian et al., 2009):

- Shareholder value;
- Management hubris;
- Environmental conditions; and
- Company attributes.

### 2.3.1 Value Creation

**Efficiency**: Companies may acquire to gain efficiency. Financial market experts have evaluated if M&As are driven by a goal to boost operational efficiency to minimise the cost of value generation. Banerjee & Eckard (1998) discovered that the first M&A wave came with horizontal bid-up by the market. Samples before 2009 showed increases in long-term capital asset efficiency and the provision of public accounting service delivery provided further support (Haleblian et al., 2009).

**Resource redeployment**: According to Haleblian et al., (2009), managers see horizontal acquisitions as a way to make it easier to transfer competencies and redistribute assets to achieve economies of scale and considerable realignment of resources between acquirers and targets. Additionally, another research by King et al., (2008) demonstrated an association between acquirer abnormal returns and how well the company resources fit between the target and acquirer firms. Similar to this, Karim & Mitchell (2000) noted that acquiring companies experienced more resource change compared to that of target companies.

**Market discipline**: Haleblian et al.,(2009) found that additional financial research indicates that when acquisitions can be used to discipline underperforming managers, value may be enhanced. Acquisitions, according to agency theorists, can shield shareholders from bad management. Research has shown that when an acquisition has been completed, chief executive officers (CEOs) of acquired enterprises frequently get fired, which was consistent with this idea (Haleblian et al., 2009). This was supported by Krug and Hegarty (1997) that found that a high number of existing CEOs exit the acquired company to make way for new CEOs. Walsh (1998) also observed that senior management of acquired companies tend to experience restructuring with some that face dismissal.

### 2.3.2 Environmental Factors

**Environmental uncertainty and regulation**: Haleblian et al., (2009) found that environmental uncertainty raised both the likelihood of acquisition and license agreements. Additional research has examined the impact of environment factors on acquisition likelihood in general and corporate portfolio restructuring. According to Haleblian et al., (2009), highly diverse businesses are more likely to pursue acquisitions as environmental uncertainty decreased, but less diversified businesses experienced the opposite.

### 2.3.3 Transaction Characteristics

**Method of payment**: It was common for fund managers to transact with cash when there was a belief that the acquirer was undervalued and with stock when the belief was that the acquirer was overvalued (Haleblian et al., 2009). This suggests that M&A deals financed by stock should be viewed by the market as a sign of overvaluation by the acquiring firm. Travlos (1987) demonstrated that cash-financed transactions benefit the bidding enterprises shareholders more. This evidence, however, was not as obvious as some might imply. For instance, Healy et al. (1992) showed conflicting outcomes by reporting zero impact of remittance type on acquirer book

value performance. Haleblian et al., (2009) reported that appreciable operational similarities between cash and stock transactions, but it was found that the announcement and post-acquisition market returns of share transactions were lower compared to cash transactions. This was supported by Fuller et al. (2002) that found that cash offers generate significant returns during M&A transaction announcement.

**Transaction type**: Bruner (2004) described a tender offer as a publicly announced proposal by a potential buyer, inviting all shareholders of a listed company to sell company shares. Tender offers generally perform better than mergers (Agrawal et al., 1992), largely due to the use of cash as a funding method. Haleblian *et al.,* (2009) reported that Rau & Vermaelen (1998) found that post-acquisition performance of lower net book value was significantly worse compared to high net book value bidder entities. A conclusion was made that management of low net book value enterprises might proceed with M&A decisions that are less wise than managers of other enterprises, indicating the significance of prior trading experience on M&A returns.

### 2.3.4 Other M&A Outcomes

Institutional investors can simultaneously own shares in both the acquiring and target companies. The dual holdings was referred to as overlapping institutional ownership and can play a pivotal role in shaping the outcomes of M&A. Goranova *et al*. (2010) argue that Such overlapping ownership can diminish opposition to mergers, as institutional investors holding stakes in both the acquiring and target companies might support transactions that enhance the value of the overall portfolio, even if it comes at the cost of one firm. While this alignment across both parties can ease the path to deal completion, it may also weaken the drive to secure the most favourable terms for each company's individual shareholders. Research by Gaspar *et al*., (2005) has revealed that companies subject to be acquired, that have institutional short-term owners have a higher chance of being the subject of an acquisition offer and would typically fetch lower premiums. This result

implies that enterprises with short-term owners have poor negotiating positions in M&As, allowing management to advance with acquisitions that reduce shareholder wealth (Gaspar *et al*., 2005).

## 2.4 Short-term Share Price Performance

Short-term share price movement a few days before M&A transaction announcement and a few days after the event was a popular method to determine share price gains or losses. As an illustration, M&A in India were studied using the event study model which includes analysing data by regressing, and it was discovered that M&A across the border, particularly in the information technology industry, created more value for shareholders than domestic M&As (Kohli & Mann, 2012).

Bruner (2004) compiled shareholder return studies for M&A, including both good and unfavourable outcomes from the target and acquirer perspectives. Twenty of the 44 samples that were analysed indicated negative abnormal returns, and 13 of those 20 samples were found to be significant (0.05 level employed). Twenty-four out of the 44 samples showed positive AR, and 17 samples were found to be significant (0.05 level employed). The general findings by Bruner (2004) were that there are no aggregate abnormal returns to acquiring enterprises.

## 2.5 Determination of M&A Positive Outcomes

Three questions should be asked to evaluate the performance of M&A transactions (Bruner, 2004). These are:

- Did the MRH stock price increase? In other words, was shareholders value higher than it was prior to the announcement?
- Did the MRH outperform the Standard and Poor's (S&P) industry index? In other words, are shareholders wealthier compared to mining investments with similar levels of risk?

- Are shareholders wealthier following the M&A than if the M&A deal had failed?

A study by Stafford (2012) found that Bruner (2004), recommended the following four methodologies employed in answering questions 1 and 2 above:

- Event study;
- Accounting studies;
- Surveys of executives;
- Clinical studies.

## 2.6 Using Event Study to Measure Stock Price AR

Fama *et al*., (1969) developed foundational principles on the event study methodology. Since then, M&A studies by finance researchers have widely adopted the event study model. According to Krishnakumar & Sethi (2012), the event study methodology is a popular method of choice for most M&A studies. Although the short-term event was adopted by most M&A studies, exercising caution was important as confounding events can affect the findings of a study (McWilliams & Siegel, 1997). These could include lodging a deficit lawsuit, introduction of a new product, declaration of dividends, imminent merger announcement, major government contract award and change in key executive.

Typically, a 200-day event window was used as an the estimation period, starting from -200 to -50 days before the event date. Different time frames ranging from (-1, +1) through (-49, +50) to (+25, +100) were used to calculate the short-term window of events (Krishnakumar & Sethi, 2012). McWilliams & Siegel (1997) found that, longer-term studies are sensitive to confounding effects (as it was highly likely that to find that companies have experienced confounding events) than shorter periods. Confounding effects include restructuring key executive, securing a government contract,

dividends declaration, upcoming merger, new product announcement, damage law suit and unexpected earnings announcement. Researcher Markides (1992) selected only companies that had no significant confounding effects such as headline earnings per share, dividends declarations or share buybacks within 5 days before and after the announcement event. McWilliams & Siegel (1997), followed similar practice by eliminating companies that had confounding effects or making assumptions that there were no confounding effects during the event 2, 3, 5, and 11 day windows, as well as the longest window. Therefore, this study used a short-term event study model to test statistics of significant stock price gains of the acquiring MRH and the gains over the event period.

Mushidzhi & Ward (2004) noted that Fama *et al*., (1969) pioneered the following four models, which are enumerated and can be used to calculate expected returns:

- Mean Adjusted Model – the share price return of the acquiring MRH was anticipated to be equivalent to the returns before the estimating period;
- Market Model – the share price return of the acquiring company calculations are modified to account for the risk of the MRH concerning the market;
- Market Adjusted Model – over the event window, the acquiring MRH was anticipated to produce similar returns to that of the market; and
- Control Portfolio Model – the acquiring company was included in a portfolio of companies and the expected return would be equal to that of the grouped MRH over the event.

CAPM used to determine expected returns “considers the risk-free return and volatility of the risk-free return to market return as the only determinants

of stock price" (Mpofu, 2011, p. 323). However, using the market model was favoured over using CAPM (Krishnakumar & Sethi, 2012). This was also supported by Dyckman *et al*., (1984) that found that the Market Model performs significantly better (at the 5% level) compared to the Mean Adjusted or the Market-Adjusted returns models.

## 2.7 Gaps in Existing Knowledge

The number of M&A papers published from 1992 to 2008 was analysed to gauge interest in the subject of acquisitions. The analysis showed that the majority of published acquisition research came from the management and finance sectors (covering all industries). This informs that there was a significant gap that was not covered by research from other disciplines such as engineering. This was supported by the report done by Haleblian *et al*., (2009) that a review of acquisitions outside finance and management studies would be beneficial because it encourages interdisciplinary learning. The same authors encouraged further research that develops a standard to guide the selection of suitable performance metrics by researchers. In addition, the research would promote the use of additional acquisition performance metrics outside of CAR, accounting-based returns and acquisition premiums used by managerial studies.

Out of the relevant M&A literature, this study found that in South Africa, only two studies were done under the engineering (mining in particular) discipline in the last 20 years. The studies are:

- A value assessment of mergers and acquisitions in the South African Mining Industry – the Harmony ARMgold example. This 2010 quantitative study used deal objectives, financial (dividends per share (DPS), earnings per share (EPS), return on investment (ROI), price earnings ratio (P/E) ratio and debt to equity ratio (D/E) and non-financial indicators as a guide to assess value in M&A. In this study,

a sample of 18 deals was selected from 138 mining deals that took place from 2003 to 2008 was used. In the opinion of Osae *et al*., (2011)., further work should research models that can be used to determine initial deal reaction from the stock market, deal objectives, and financial and non-financial parameters to assess the potential impact on shareholder value.

- In a 2016 M&A research on funding models used in mining BEE transactions in the SA, 38 samples were randomly selected from a population of 351 transactions that took place from 1994 to 2012. Nhasengo, (2016)., reported that to achieve a confidence level of 95% at a 5% margin of error, a minimum sample size of 184 transactions was required. In the opinion of the author, a similar quantitative study can conducted using a larger sample.

Haleblian *et al*., (2009) found that unbundling can be used in analysing performance over a long-term window (for example, three to five years). This can be under the assumption that when a MRH unbundles an acquisition within five years, the acquisition yielded poor performance. However, unbundling as a measure has shortcomings as well, including unbundling for profit or difficult-to-track divestitures. Other research that was reviewed by Haleblian *et al*. (2009) demonstrated that the composition of samples, including distinctions such as targets versus bidders, larger corporations versus small businesses, and publicly traded firms versus privately held firms, exerted influence on the results of acquisition studies.

Haleblian *et al*., (2009) found significant differences in implemented criteria to select research parameters. Haleblian *et al*., (2009) made the conclusion that opportunities exist in the results due to sampling differences from one

study to another. Adding to the sampling difference, a study by Ward & Muller (2010) that researched the long-term share price reaction to BEE announcements on the Johannesburg Stock Exchange (JSE), found only one paper that examines the response by shareholders to BEE announcements. Ward & Muller (2010) argued that the paper suffered from a small sample of 20 transactions and weak methodology. Ward & Muller (2010) used event study methodology on a population of 118 announcements and found a positive CAR return of around 10% after the first year. However, this dissertation finds that the study lacked a descriptive analysis of its variables.

A study by Mpofu (2011) of the SA All-Share Index and the economic variables from 2002 to 2010, the study found that the mining index had a positive correlation with the benchmark administrator of index series (FTSE/JSE) index. Different to the Ward & Muller (2010) methodology and other M&A reviewed by this report, Mpofu (2011) conducted descriptive analysis before regressing. However, different to studies by Osae *et al*., (2011); Nhasengo, (2016); Ward & Muller, (2010); Mpofu, (2011) and Mabasa, (2019); which all used JSE indices as benchmarks, this study used S&P Mid-East and Africa Emerging BMI Materials (Industry Group) Index as a benchmark/independent variable. This index was used by global investors assessing investment into SA mining.

# 3 RESEARCH METHODOLOGY

## 3.1 Introduction

The focus of this chapter was to establish a robust framework that aligns with the objectives outlined in the literature review. This chapter has not only detail the chosen methodology but also offer a defence for its selection, providing a comprehensive understanding of its relevance. Key components include specifying the population of interest, outlining the sampling method and justifying the sample size, would be thoroughly addressed. Additionally, the chapter has outlined the research design, the data collection process, and rationalize the chosen data analysis approach.

To further contextualize the methodology, the purpose of this study was to research whether mining M&A deals that took place between 1998 and 2022 in the mining industry, have been beneficial to shareholders. Drawing from the insights gleaned in the literature review, this dissertation has used quantitative research methods to analyse data. Quantitative approach has enabled the use of regression analysis, correlation, efficient frontier analysis and hypothesis testing. Utilising data from secondary source, such as S&P Global database, this study aims to conduct a thorough examination of short-term share price performance and sample portfolio performances in order to offer insights into mining M&A transactions.

## 3.2 Population

The study focal population encompassed significant acquisitions undertaken by MRH during the span from 1998 to 2022. To delineate an acquisition as MRH, the criteria employed were based on the S&P Global database selection criteria.

### 3.2.1 Sampling Method and Size

To conduct this research, M&A transactions involving acquirer companies were considered. The study focused on M&A transactions completed between January 1998 and December 2022. The criteria in Table 3-1 for inclusion in the analysis were defined as follows:

**Data Source**: The data for this study was sourced from S&P Global database, which provide a comprehensive information on worldwide announced, pending, completed, and cancelled M&A transactions. The research questions and hypotheses guided the selection of relevant data, focusing specifically on M&A activities in South Africa.

**Deal Completion**: The M&A transactions included in the analysis had to be completed. This criterion was essential for measuring value creation through mergers and acquisitions, as non-completed deals might not exhibit significant price movements.

**Transaction geography**: M&A transactions within the South African geography have impacted a diverse sample population of companies across various industries. The sample population encompasses entities operating in sectors such as mining, finance, telecommunications, and retail, reflecting the broad spectrum of South Africa's economic landscape. The mining industry, with its abundance of natural resources, has been a focal point for M&A activities, influencing the sample population involved in resource exploration, extraction, and processing. The complexity of South Africa's geography, which includes urban centers, industrial regions, and mineral-rich areas, contributes to the diversity of M&A opportunities and challenges faced by the sample population of companies engaging in strategic transactions.

**Transaction industry**: South Africa, renowned for its abundant mineral resources, has seen numerous M&A activities reshaping the ownership structure and operational landscape of mining companies. The sample

population in the mining industry encompasses a variety of players, including large-scale multinational corporations, local mining entities, and emerging BEE companies seeking increased participation. M&A transactions in this sector often aim to optimise resource extraction, enhance operational efficiencies, and navigate the complex regulatory environment. The mining industry sample population reflects the diverse range of commodities, including gold, platinum, coal, and diamonds, highlighting the intricate nature of M&A transactions within this crucial sector of the South African economy. Additionally, considerations related to environmental sustainability, community engagement, and adherence to BEE policies further influence the composition and dynamics of the sample population in the South African mining industry's M&A landscape.

**Announcement date**: The sample population in the context of M&A transactions often revolves around the critical "announcement date." This date marks a pivotal moment when companies publicly disclose their intention to merge or acquire. The sample population during this phase includes a spectrum of stakeholders, such as investors, analysts, regulatory bodies, and the companies involved. Investors closely scrutinise the announcement date, assessing potential impacts on stock prices and future prospects. Analysts analyse the strategic implications and financial viability of the deal. Regulatory authorities evaluate the compliance of the transaction with existing laws. For the companies, the announcement date sample population extends to internal teams, employees, and sometimes the broader industry, as the news can trigger reactions, speculations, and adjustments in the competitive landscape. The announcement date, therefore, serves as a focal point for various actors, each contributing to the diverse and dynamic sample population involved in M&A transactions.

**Announcement period**: Only mergers and acquisitions were considered, excluding other deal types such as investments and joint ventures. The deals had to be announced between January 1, 1998, and December 31,

2022, covering two decades to capture various M&A waves and economic cycles.

**Buyer listed on a stock exchange**: Both the acquirer and target companies had to be publicly listed on the JSE. This ensured the availability of daily share price movements, a requirement for the event study methodology.

**Shareholding**: In the realm of M&A transactions, the "shareholding" sample population was a critical facet, comprising shareholders who play a pivotal role in shaping the fate of a company undergoing a merger or acquisition. This group encompasses a diverse array of individuals, institutional investors, and entities holding shares in the companies involved. The dynamics of the shareholding sample population become particularly pronounced during M&A events, as shareholders weigh the potential impact on stock prices, dividends, and their overall investment portfolios. Large institutional investors, such as pension funds or mutual funds, hold substantial sway in these transactions, often influencing the decision-making process. Additionally, individual shareholders, including retail investors, may be closely monitoring the developments, as their financial interests are directly tied to the outcome of the merger or acquisition. As M&A transactions unfold, the shareholding sample population becomes a key determinant of the success and reception of the deal, reflecting the diverse perspectives and interests of those invested in the companies undergoing strategic changes. Transactions without shareholding value or weight expressed in percentages, did not make the cut and transactions with equity share were selected.

**Eight to nine months data**: Sufficient financial data before the announcement, spanning approximately 250 days before and at least 10 days after the announcement, was necessary. This timeframe aligns with established estimation periods in related studies.

**Price Data and Majority Stake**: Acquiring companies were required to have at least 200 days of price data before the M&A announcement. A majority stake in the target company, defined as the purchase of 50% or more stake, was necessary for inclusion. This criterion ensures a substantial influence on the target company's operations.

**Transaction value**: The final sample size aimed to account for more than 90% of the total value of M&A activities after applying all selection criteria. This ensured the inclusion of the most significant transactions, likely to have a substantial impact on the market.

*Table 3-1: Sample selection procedure*

| Selection Criteria | Count |
|---|---|
| Data set (transaction) collected was available on S&P Capital IQ Pro platform and the transaction type was M&A | 250000 |
| The transaction status was completed. | 250000 |
| The transaction geography was in SA | 10655 |
| The transaction industry was classified under metals and mining | 1124 |
| Transactions have an announcement date | 1124 |
| The deal was announced between 01 January 1998 and 31 December 2022. | 1092 |
| Buying company is/was listed on a stock exchange | 319 |
| The M&A was announced with number of shares acquired | 162 |
| Sufficient financial data prior to the announcement was available to use. Stock prices are available 8 months before the announcement and at least ~10days after the announcement for acquirers. | 53 |
| The M&A was announced with transaction value | 41 |

From a total of 250,000 M&A transactions documented in the S&P Global database over the 24-year period, 41 transactions met these stringent selection criteria expressed in Table 3-1. While this judgmental sample was larger than previous studies, it was smaller than initially hoped for the population of relevance. Each of the 41 transactions was studied, acknowledging the limitation on statistical inferences due to the non-random sampling approach. This approach aligns with previous research

methodologies, including Smit & Ward (2007) study, where such limitations were noted without imposing restrictions on the overall research design.

The 41 transactions were then grouped into 10 sample groups shown in Table 3-2. The sample groups derived the structure of data analysis.

*Table 3-2: Sample grouping*

| Sample Group | Sample count |
|---|---|
| Full sample (The M&A was announced with transaction value) | 41 |
| Diversified Metals and Mining | 11 |
| Gold | 9 |
| Precious Metals and Minerals | 15 |
| Steel | 4 |
| JSE Listed BEE Buyers | 13 |
| 2017 – 2022 | 8 |
| 2011 - 2016 | 7 |
| 2005 - 2010 | 20 |
| 1998 - 2004 | 6 |

In the comprehensive landscape of M&A transactions within the South African mining industry, diverse sample groups have been identified to discern patterns and trends across different time frames. The "full sample" encapsulates a holistic view, providing insights into the overall dynamics of M&A. Delving into specific sectors, such as diversified metals and mining (DMM) allows for a more nuanced understanding of M&A activities within that industry subset. The focus on gold and precious metals and minerals (PMM) on valuable resources, shedding light on the distinctive challenges and opportunities associated with these commodities. Exploring steel as a subset reflects a specific branch of the mining industry with its own unique characteristics and considerations in M&A transactions. The categorization of JSE listed BEE buyers (JSELBEEB) delineates transactions involving companies listed on the JSE with BEE status, emphasizing the role of empowerment initiatives in the mining sector. The temporal breakdowns

from 1998 - 2022 provide a chronological lens, enabling an analysis of how M&A trends have evolved over distinct periods, uncovering potential shifts in strategies and market dynamics. Each sample group contributes to a multifaceted exploration of M&A activities, enriching the understanding of the intricate fabric of the South African mining industry.

### 3.3 Assumptions and Research Design

McWilliams & Siegel (1997) noted three assumptions that can be used to identify abnormal returns:

- Market efficiency – all available information was incorporated in share prices;
- Confounding effects – no other major event occurs (within event window); and
- Unanticipated events – the market becomes aware during event announcement.

### 3.4 Design

Research design was as follows:

- Sample size – As normality assumptions in relation to large samples are used in event study methodology, this study sought to use a large sample.
- Outliers identified by nonparametric tests – in event studies, outliers tend to subject test statistics sensitivity. Small samples increase the impact on returns of any MRH on the sample statistics. This supports the choice of using large samples.

- Event window period – In support of the short-term window of events, Brown and Warner (1980, 1985) found that using a long-term window of event significantly reduces the power of the test statistics ($Z_t$), leading to erroneous conclusions about significant events.
- Confounding effects – Many MRH have multi-commodities and footprint in several countries, which makes it highly frequent for significant events to occur. Therefore, short-term event windows be used as it offers confidents (confound effects easily identifiable) that an AR was due to an event.
- Explanation of abnormal returns – showcase of ARs cross sectional variation in returns of MRH support or was in line with the study theory.

This study adopted the design above motivated by the research design outlined by McWilliams & Siegel (1997)

### 3.5 Data Analysis Approach

Most of the data to be used in this report was secondary data from a database which University of Witwatersrand has access to. Additional data was gathered from MRH audited financial reports.

The data analysis approach employed in this study integrates methodologies from various scholars, emphasizing the event study technique to assess the impact of corporate events on share prices. Drawing from Fama *et al*., (1969) and Binder (1998), the event study method serves as a standard practice for measuring price reactions to announcements. It plays a crucial role in testing the market efficiency hypothesis and examining the wealth impact on shareholders during events

such as mergers, acquisitions, leadership changes, and earnings announcements.

**Event Study Approach:** An event study serves as a statistical method to evaluate the influence an event has over the value of a company. Fama *et al*., (1969) introduced the event study methodology, specifically tailoring it for application in the new centre for research in security prices (CRSP) monthly data for New York Stock Exchange (NYSE) stocks (Binder, 1998). This approach has since been widely utilised, especially in scrutinizing a company stock behaviour during pivotal events such as M&As, leadership changes, and earnings announcements.

Binder (1998) stated that event study method has evolved into a standard procedure for gauging price reactions to announcements or events. Its common applications include testing the null hypothesis that the market efficiently incorporates information and assessing market efficiency under the assumption that publicly available information comprehensively influences the wealth of a company shareholders.

The event study proves particularly effective in estimating value creation through M&A, aligning with Fama *et al*., (1969) market efficiency hypothesis. This hypothesis puts forward that share prices mirror the present value of anticipated future cash flows from the assets of a company, taking into account all available information about current and future earnings potential of company. This assisted in formulating the following hypothesis:

*H0*: M&A transaction announcement does not create cumulative average abnormal return for buying mining companies and does not create value for shareholders.

In applying the event study methodology to arrive at testing the hypothesis, McWilliams & Siegel (1997) recommended the following steps:

Step 1: Establishing a significant event that imparts fresh information to the market, prompting potential financial reactions,

Step 2: Develop a theoretical framework that rationalizes why this new information would elicit a financial response from market participants,

Step 3: Identify a group of companies that are impacted by this event and note the specific dates when the event occurs for each company,

Step 4: Determine an appropriate event window and provide a rationale for its duration, especially if it extends beyond two consecutive days,

Step 5: Adjust or remove companies from the analysis if they are affected by other pertinent events during the defined event window,

Step 6: Calculate abnormal and cumulative abnormal returns within the event window and evaluate their statistical significance through appropriate testing methods,

Step 7: Present findings including the percentage of negative returns and relevant statistical test results such as the t test statistic,

Step 8: Utilise bootstrap techniques

Step 9: Develop a theoretical framework to explain why abnormal returns vary across different firms and conduct econometric tests to validate this theory, and;

Step10: Include a detailed data appendix (5) that lists the names of firms and their respective event dates for transparency and reference purposes McWilliams & Siegel (1997).

Seps 1 to 10 were followed in this research to detail step a) to step h) below:

**Step a) – M&A Transaction announcement:** Involved using S&P Global database to identify relevant announcements, considering factors like deal structure, industries, and premium. Data cleaning steps included removing unlisted acquirers and cases with missing information.

**Step b) – Theoretical Framework:** The event study methodology was employed to assess potential abnormal effects on share price performance resulting from unexpected corporate events or announcements. This study aimed to quantify CAAR, serving as a foundation for analysing factors influencing investor perceptions of merger and acquisition success.

McWilliams & Siegel (1997) emphasized the popularity of event study methodology due to its resistance to insider manipulation compared to accounting profits. These authors argued that stock prices, reflecting the discounted value of all future cash flows, inherently embody the true value of a company, incorporating all relevant information. Krishnakumar & Sethi (2012) corroborated this, highlighting the widespread use of event study methodology in M&A share price performance research.

To apply an event study methodology, certain assumptions must be met:

- Efficient markets: Share prices swiftly incorporate all relevant information,
- Unanticipated events: The event has no prior indication, with traders learning through the announcement, and
- No confounding events: No other events influence the outcome (McWilliams & Siegel, 1997).

Potential confounding events identified by McWilliams & Siegel (1997) include impending M&As, new product announcements, unexpected earnings, executive changes, dividend declarations, large damage suits, or major government contract signings. These authors suggested a short-term event window of three to five days, emphasizing control over confounding events.

**Step c) - Determine Dates:** To initiate the event study, it was imperative to identify specific dates for the event window. Mabasa (2019) found that other studies recommended an estimation of 8 months minimum period preceding the event was selected. This period allows for a comprehensive understanding of the normal returns and minimizes sampling errors in the chosen model.

The event window, spanning 21 days (-10, 0, 10), was strategically chosen to capture results 10 days before and after the event announcement. This window aligns with common practices in event studies, ensuring a comprehensive analysis of stock price behaviour.

For the short-term event window, a 200-day period preceding the announcement date was recommended to estimate market-model (explained in step 6 to follow) parameters (Chang et al., 2015 and Masulis et al., 2007). This period should start 210 days before the announcement and end 10 days before, ensuring accurate parameter estimation and noise reduction. The market-model (favoured over CAPM) was endorsed by Chang et al., (2015), Fischer (2015), and Masulis et al., (2007) for calculating expected benchmark returns.

**Step d) - Abnormal Returns Computing and Significance Testing:** Various models exist for calculating expected returns, including the CAPM, the arbitrage pricing theory (APT), market-model, net of market returns, and

net of characteristics matched portfolio. This dissertation opted for the market-model, a statistical model using a single market factor affecting stock prices, as illustrated by the equation 1. The market-model relies on a broad-based stock index like the JSE all share index. This dissertation choose to use the S&P Middle East Africa BME index. This index was chosen due to enough data availability for the period 1998 to 2022 and was the basic index used to benchmark South African company stocks by S&P Global database.

Equation 1: $R_{it}=\alpha_i+\beta_i R_{mt}+\varepsilon_{it}$ (McWilliams & Siegel, 1997)

Where:

$R_{it}$ = the MRH i share price rate of return on day t

$R_{mt}$ = market return (index such as S&P Middle East Africa BME index) on day t,

$\alpha$ = the intercept

$\beta$ = the slope, and

$\varepsilon_{it}$ = the error term,

The actual return explained by $\alpha_i$ and the market return $R_{mt}$ multiplied by the firm's specific factor $\beta_i$, aids in calculating abnormal returns. The slope was derived from the historical covariance between the firm and market return. AR was obtained by rearranging the model equation. From estimation of the above equation, the researcher derives estimates of daily AR for the ith firm using the following:

Equation 2: $AR_{it} = R_{it} - (a_i + b_i R_{mt})$, (McWilliams & Siegel, 1997)

Where:

$a_i$ and $b_i$ are the ordinary least squares (OLS) parameter estimates obtained from the regression of $R_{it}$ on $R_{mt}$ over an estimation period preceding the event (McWilliams & Siegel, 1997)

This study used 250 to 11 days prior to the event. $AR_{it}$ represent returns earned by the MRH after the market has adjusted for the "normal" return process. That was, the rate of return on the stock is adjusted by subtracting the expected return from the actual return. Any significant difference was considered to be an abnormal, or excess, return (McWilliams & Siegel, 1997).

For each period in the event time, the abnormal returns were averaged across MRH to produce average abnormal returns (AAR) computed using equation 3, for that period. Mushidzhi & Ward (2004) stated that the reason for averaging across firms was that stock returns are noisy, but the noise tends to cancel out when averaged across a large number of firms.

Equation 3: $\mathrm{AARt} = \frac{1}{N}\sum_{i=t}^{N} ARit$

where

N = number of stocks or MRH in the sample

The performance over an extended period was assessed by summing AAR to calculate the CAAR for each stock throughout the event window. Similar to Mushidzhi & Ward (2004), $CAAR_t$ technique or method was used for this study and can be computed using equation 4.

Equation 4: $\mathrm{CAAR} = \sum_{t=0}^{T} AAR$

where

T = number of time periods being aggregated.

**Step e) to f) – Testing the MRH Returns:** Similar to test method used by (Smit & Ward, 2007), this dissertation employed a parametric test, particularly the t-test to test the null hypothesis and evaluate the significance of CAAR. Rejection at different critical levels indicates significance of CAAR and acceptance indicates insignificance of CAAR. The t-statistic calculation considers AR, CAR, AAR and CAAR.

The application of these steps allows for a thorough examination of abnormal returns, considering both the statistical and economic significance of the observed trends. These tests assessed whether the share price performance resulting from the acquisition significantly differed from zero. Following the same method, boot-strap distributions were constructed for 11 day CAARs, against which the 11 day CAARs in the event period were tested for significance. 11 day CAAR weighted graphs were plotted for each sample of this study.

**Step h) – Solver, Corelation Covariance Matrix and Efficient frontier**

**Excel Solver:** This approach employs the Excel Solver function, which leverages mixed-integer linear programming, to maximize profit or net present value (NPV). These models rely on actual monetary values (without accounting for inflation or escalation) to minimize uncertainties associated with assumptions about future costs and commodity prices (Birch, 2022).

Excel Solver, a built-in optimization tool in Excel, was frequently utilized to determine the optimal (maximum or minimum) outcome for a formula in a specified target cell. By adjusting the values in the decision variable cells, Solver ensures that the solution adheres to the defined constraints within the worksheet, achieving the desired objective in the target cell (Birch 2022).

Solver uses three algorithms to solve optimization problems:

- Generalized reduced gradient (GRG) Nonlinear, for smooth nonlinear problems.
- Linear programming (LP) Simplex, for linear problems.
- Evolutionary, for non-smooth problems.

The Excel Solver function was then used to optimize the value of profit, NPV, shareholding or any other specified value or combination of values as needed.

**Correlation:** Correlation was a function that returns the correlation coefficient of two cell ranges to determine the relationship between two properties. Array cells or reference argument which include text, logical values or empty cells are ignore. However, cells containing zero are included in a calculation. If array 1 and array 2 have a different number of data points, correlation would return a not applicable (#N/A) error. Additionally, if either array 1 or array 2 was empty, or if the standard deviation (s) of values was zero, correlation would return a division (#DIV/0!) error. A correlation coefficient closer to +1 or -1 indicates strong positive (+1) or negative (-1) correlation between the arrays. A positive correlation means that as the values in one array increase, the values in the other array also tend to increase. Conversely, a correlation coefficient closer to 0 signifies weak or no correlation between the arrays (Microsoft, 2024). The correlation function on Microsoft excel function was used in this study.

**Covariance:** A covariance function calculates and returns the population covariance, which was the average of the products of deviations for each data point pair in two data sets. Covariance was useful for determining the relationship between two data sets. The input values must be either numbers or references, arrays, or names containing numbers. If an array or reference contains text, logical values, or empty cells, the values are ignored. However, cells with zero values are included. If array 1 and array 2 have different numbers of data points, covariance would return a #N/A

error. If either array 1 or array 2 was empty, the function would return a #DIV/0! error (Microsoft, 2024).

In stock analysis, covariance was used to measure the directional relationship between the returns of two stocks. It indicates how the returns of two assets move in relation to each other, helping to determine if they tend to increase or decrease together. The covariance function on Microsoft excel function was used in this study.

**Efficient Frontier (EF)**: is a concept in finance that represents the optimal portfolio allocation to achieve the highest expected return for a given level of risk, or conversely, the lowest level of risk for a given expected return. Developed by Nobel Harry Markowitz, this theory was a key component of modern portfolio theory.

EF was typically graphed as a curve on a risk-return plot, where the x-axis represents risk (standard deviation of portfolio returns), and the y-axis represents return. The curve illustrates the trade-off between risk and return for different portfolios. Portfolios lying on the upper part of the curve are considered efficient because they provide the maximum expected return for a given level of risk, while portfolios below the curve are suboptimal as they do not offer the highest return for a given level of risk.

Investors can use the EF to make informed decisions about portfolio construction. The goal was to find the optimal mix of assets that maximizes return while minimizing risk. Portfolios that are not on the EF are considered inefficient because they either offer lower returns for a given level of risk or higher risk for a given level of return.

Additionally, the concept of the capital market line (CML) was often associated with the EF. CML was a tangent line drawn from the risk-free rate of return to the point of tangency with EF. This tangent portfolio, composed of a risk-free asset and a risky portfolio, represents the optimal

portfolio for an investor seeking the highest return with the least amount of risk (Markowitz, 1952).

Overall, EF was a powerful tool for portfolio optimization, guiding investors in constructing well-balanced portfolios that align with their risk tolerance and return objectives.

### 3.6 Chapter Summary

The methodology chapter outlines a framework for studying the impact of mining M&A transactions on shareholder value in South Africa from 1998 to 2022. Beginning with the population selection, the study focused on M&A transactions documented in the S&P Global database that met specific inclusion criteria, such as being completed deals within the South African geography, involving listed companies on the stock market and having sufficient financial data before the announcement. This resulted in a final sample size of 41 transactions, spanning different commodities across various time periods from 1998 to 2022.

The study research design adheres to assumptions of market efficiency, no confounding events, and unanticipated events, aligning with previous literature event study methodology. The event window, ranging from 10 days before to 10 days after the announcement, was chosen strategically to capture significant price movements while mitigating confounding effects. Abnormal returns were computed using the market model, and statistical tests like t-tests were employed to assess the significance of these returns.

Moreover, the methodology integrates non-parametric tests, bootstrap methods for small samples, and econometric analysis to validate theories explaining cross-sectional variation in abnormal returns. The data collection primarily relied on secondary sources like the S&P Global database, supplemented by MRH audited financial reports.

The detailed methodology encompasses various statistical techniques and theoretical frameworks, ensuring a robust analysis of the impact of mining M&A transactions on shareholder value in South Africa.

# 4 ANALYSIS AND DISCUSSION OF RESULTS

## 4.1 Introduction

This chapter has presented the comprehensive results of the study using the following structure:

- Sample descriptive statistics;
- AAR and CAAR;
- CAAR Weighted;
- Solver;
- Correlation;
- Covariance; and
- EF.

Commencing with a detailed description of the analysed sample, the chapter unfolds the depth of the analysis and subsequently provides a concise summary of the results. These results, in turn, serve as the basis for either accepting or rejecting the null hypotheses in Chapter 3 section 3.5, setting the stage for conclusion and recommendations.

Figure 4-1 shows the number of transactions found on the database that took place in the mining industry from 1998 to 2022. The research encompassed a total of 1091 M&A executed between with an average of 44 transactions per year.

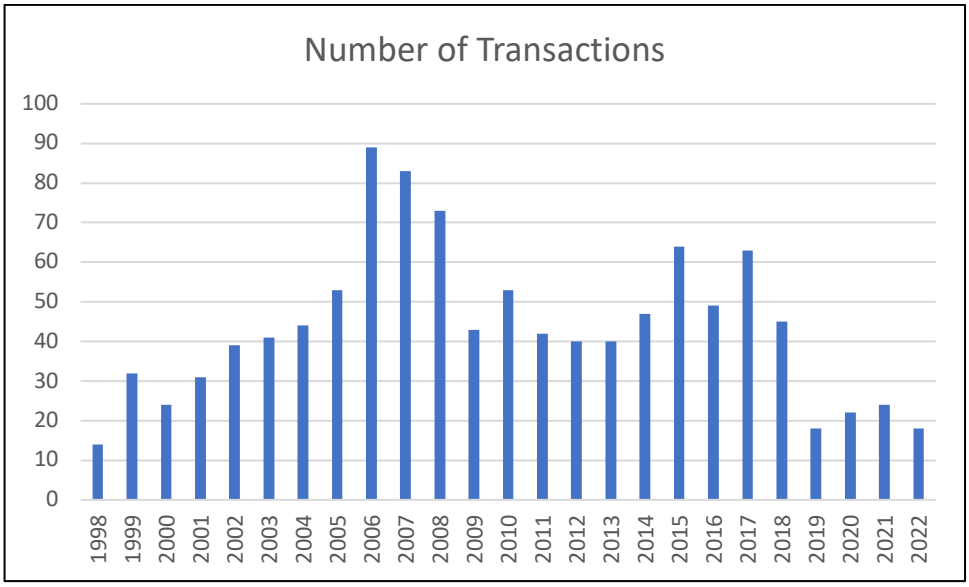


*Figure 4-1: Number of transactions from 1998 to 2022*

The number of mining transactions used to plot the bar graph in Figure 4-1 accounted for 1091 M&A activities. The trends in the graph were influenced by global economic cycles, the commodity price boom and bust and structural economic challenges of South Africa. While peaks were driven by global investor optimism and high commodity prices (2005–2007, 2014–2017), declines were caused by global crises (2008, 2020), local economic stagnation, and structural constraints post-2018. This was further explained as follows:

**Early growth (1998–2004) gradual Increase:** The South African economy and many emerging markets experienced steady recovery during the late 1990s and early 2000s. Reforms in various sectors and increased investor confidence likely supported this gradual growth in transaction activity (National Treasury, 2001). The global commodity boom (especially in gold, coal, and platinum) starting in the early 2000s also contributed to increased investments and transactions in resource-based sectors (Humphreys, 2015).

**Peak activity (2005–2008) record transaction levels:** From 2005 to 2008, the global commodity super cycle driven by rapid industrialization in China and other developing economies led to record-high commodity prices. In South Africa, the mining sector benefited significantly which led to increased M&A deals (Humphreys, 2015). Emerging markets like South Africa, became attractive investment destinations during this period, which led to a sharp rise in capital inflows and transaction volumes (World Bank, 2009). The mining and financial sectors witnessed significant consolidation through M&As to enhance scale, efficiency and competitiveness (PwC, 2007).

**Decline post 2008 (2009–2013) impact of the global financial crisis:** The global financial crisis led to a sharp contraction in economic activity worldwide. South Africa was not immune, and the number of transactions dropped significantly as credit markets tightened, investor sentiment weakened and companies paused expansion plans (IMF, 2009). Post 2008, commodity prices began to decline, which further reduced transaction activity in resource-dependent sectors like mining (Humphreys, 2015). This led to many companies focusing on survival rather than expansion, prioritised cost-cutting and restructuring rather than engaging in transactions (McKinsey & Company, 2009).

**Temporary recovery (2014–2017) renewed growth in transactions:** There was a moderate recovery in commodity prices starting in 2014 leading to renewed investor confidence in the mining sectors (Humphreys, 2015). This led to companies using M&A and restructuring to position for growth or to take advantage of undervalued assets that became available after the crisis (McKinsey & Company, 2015).

**Steady decline (2018–2022) structural and economic challenges:** The ongoing energy crisis (load shedding by Eskom - SA power utility) and deteriorating infrastructure have negatively impacted businesses, which reduced appetite for transactions putting strain on commodity markets. While there were some commodity price spikes such as gold and PGMs,

the overall volatility in resource markets led to reduced confidence in long-term investments in South Africa. Regulatory uncertainty, lack of investment and electricity shortages continue to hamper mining M&A during this period (National Treasury, 2021).

## 4.2 M&A Analysis

### 4.2.1 Full Sample

The table below provides a summary of the descriptive statistics for two variables (Transaction value [TV] and Shareholding [Weight]) in a sample of 41 observations. For each variable, it includes the mean, standard error, median, standard deviation, sum, count, and the 95% confidence interval. This statistical summary helps to understand the central tendency, dispersion, and reliability of the sample data.

*Table 4-1: TV and weight descriptive statistics of full sample group.*

| Full Sample | Mean | Std Error | Median | Std Dev | Sum | Count | Conf Level (95%) |
|---|---|---|---|---|---|---|---|
| TV | 749,48 | 419,18 | 38,77 | 2684,06 | 30728,6 | 41 | 847,19 |
| Weight | 35,42 | 3,92 | 32,76 | 25,08 | 1452,27 | 41 | 7,92 |

From Table 4-1 above, the average value for TV was $749.48mill (million) and with a weighting average of 35.42%. The smaller the standard error, the more accurate the mean was as a reflection of the true population mean. A TV standard error of $419.18mill has a relative standard error of 56%. This shows high variability in the M&A deal value sizes. The sample has a Weight standard error of 3.92%. This results in a relative standard error of 11%. This shows a low variability in M&A deal stake being bought by acquiring companies. The middle value of the sample when the data points are arranged in ascending order with TV of $38.77mill and Weight of 32.76%. The standard deviation, which measures the amount of variation

or dispersion in the sample has a TV of $2684,06mill and Weight of 25.08%. The total sum of all the values in the sample TV amounted to $30,728.6bill and with Weighting of 1452.27%. The number of observations in the sample were 41 for both TV and Weight. The 95% confidence interval around the mean range indicates that there was a 95% probability that the true population mean lies within the $847.19mill TV interval and 7.92% weight interval.

Table 4-2 presents a detailed analysis of the AAR and CAAR over different periods surrounding the full sample M&A transaction announcement events.

*Table 4-2: AAR and CAAR for full sample group.*

| | Full Sample | | | |
|---|---|---|---|---|
| Period (days) | AAR% | t-stats of AAR% | Window Period | CAAR% |
| 10 | 1,85 | 0,12 | | |
| 9 | 1,67 | 0,1 | | |
| 8 | 1,43 | 0,09 | | |
| 7 | 1,93 | 0,12 | | |
| 6 | 3,13 | 0,2 | | |
| 5 | 2,95 | 0,19 | | |
| 4 | 2,92 | 0,18 | | |
| 3 | 1,86 | 0,12 | (0;+10) | 22,7 |
| 2 | 2,18 | 0,14 | (0;+5) | 12,07 |
| 1 | 2,16 | 0,14 | (0;+2) | 4,97 |
| 0 | 0,63 | 0,04 | (0;0) | 0,63 |
| -1 | 1,96 | 0,12 | (-2;0) | 4,91 |
| -2 | 2,32 | 0,15 | (-5;0) | 10,66 |
| -3 | 1,66 | 0,1 | (-5;+5) | 22,72 |
| -4 | 2,16 | 0,14 | (-10;+10) | 43,94 |
| -5 | 1,93 | 0,12 | (-250;+10) | 46,21 |
| -6 | 1,62 | 0,1 | (-250;0) | 24,14 |
| -7 | 1,9 | 0,12 | (-250;-11) | 2,27 |
| -8 | 2,18 | 0,14 | | |
| -9 | 3,27 | 0,21 | | |
| -10 | 2,24 | 0,14 | | |

In Table 4-2, number of days relative to the event date was in the period (days) column, with positive values indicating days after the announcement event and negative values indicate days before the announcement event. for Each specific day has AAR% and the t-stats of AAR%, indicating the statistical significance of the abnormal return. The WP column shows the window period that were calculated for specific periods of interest around the announcement date. These windows aggregate the AARs over multiple days to calculate the CAAR over the specified window period.

Days -10 to -1 show the AAR% and t-stats of AAR% for each day leading up to the event. For example, on day -10, AAR% was 2.24% with t-statistic of 0.14 significance level. Day 0 which represents the event day, with an AAR% of 0.63% and a t-statistic of 0.04. Days 1 to 10: Shows the AAR% and t-stats of AAR% for each day following the event. For instance, on day 10, the AAR% was 1.85% with a t-statistic of 0.12.

Short-term windows (e.g., WP(0;+5) and WP(-5;+5)) showed strong positive reactions, with CAARs reaching up to 22.72%. Over longer periods, such as WP(-250;+10), CAAR% rose significantly to 46.21%, indicating sustained value creation leading up to and after the event.

AAR% values indicate the abnormal returns on each specific day, showing the market reaction to a MRH transaction event. T-stats help to understand the statistical significance of returns. Higher t-statistics suggest more statistically significant abnormal returns. CAAR% over different window periods help to aggregate the impact of the event over time, giving a broader view of the event influence on returns. Larger CAAR% values in certain windows (e.g., (0;+10), (-10;+10)) indicate a more substantial cumulative effect over those periods. This detailed breakdown helps in analysing the performance and impact of an event on stock returns, allowing for better investment decisions and understanding of market reactions.

**CAAR Weighted:** Figure 4-2 presents CAAR over an 11-day window period, with the values weighted. The graph was useful for visualizing the impact of MRH transaction event on stock returns, illustrating both the average effect and the variations within the sample.

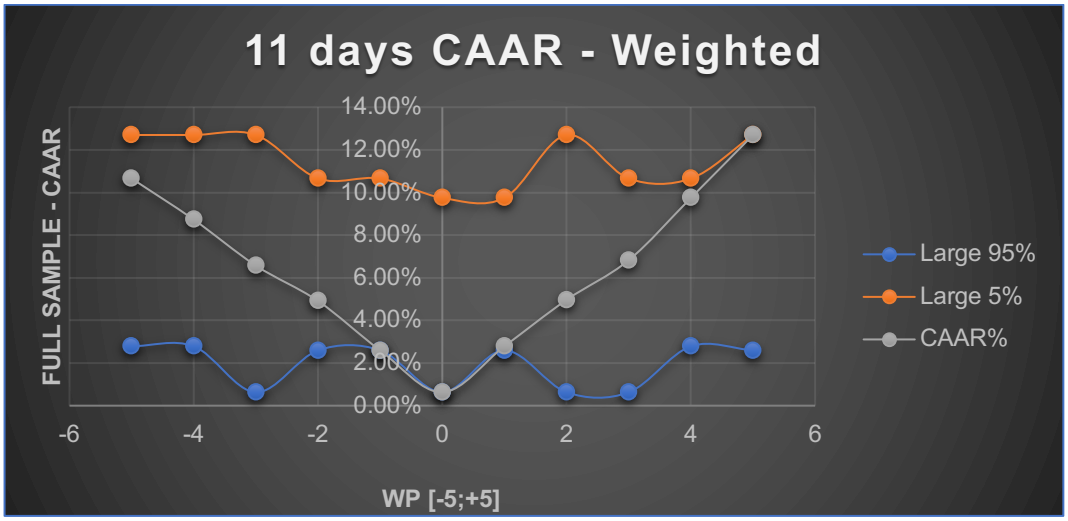


*Figure 4-2: 11 days CAAR (weighted): full sample.*

The X-Axis (WP [-5;+5]), represents the window period in days, ranging from 5 days before to 5 days after a transaction announcement. The Y-Axis (full sample - CAAR) represents CAAR in percentage. CAAR% (Grey Line) represents the actual CAAR over the 11-day WP. Large 5% (Orange Line) represents the CAAR for the largest 5% of values in the sample. It shows higher values compared to the full sample. Large 95% (Blue Line) represents the CAAR for the largest 95% of values in the sample. It shows lower values compared to the full sample. Large 5% and 95% confidence intervals were constructed using bootstrap sample data.

CAAR% starts at around 6.0% on day -5, dips slightly to around 5.5% on day -3, then reduces to about 0.9% by day 0 (event day), and finally peaks at around 12% by day 5. The Large 5% line starts at about 12.5% on day -5, drops slightly to around 11.5% on day -2, and fluctuates but stays above

9% throughout the window period. The Large 95% line remains close to 2% for most of the WP with slight variations.

The graph shows that the CAAR reduces leading up to event day and increases after the event day (day 0), suggesting a positive impact of the event on the sample. The significant difference between the CAAR of the largest 5% and the largest 95% indicates that a small portion of the sample experienced much higher abnormal returns compared to the rest. The trends in the graph help in understanding the effect of the event over the period and the distribution of abnormal returns among different percentiles in the sample.

### 4.2.2 DMM

The DMM Sample data present descriptive statistics on Table 4-3 for a dataset points for shareholders or MRH seeking a diversified metals and mining M&A strategy. Diversified metals in this study refers to different types of commodities. For example, a MRH with ore body licences or operating mines that are mining gold, platinum, iron ore, manganese, chrome, diamonds, coal and other minerals in South Africa. Transactions that made it into this sample group include:

- Orion Minerals Limited listed (ORN) on the ASX stock exchange with ticker symbol ASX:ORN. Orion made a transaction announcement (on 03 January 2017) of acquiring Prieska copper mine & Marydale project. Orion acquired 73.33% stake (shareholding/weight) for US$66.77 mill (TV);
- Northam Platinum Holdings Limited listed (at the time) on the JSE with ticker symbol JSE:NPH. Northam made a transaction announcement (on 01 July 2012) of acquiring Northam Chrome Producers Proprietary Limited. Northam acquired 70% stake for $10 mill;

- Pohang Iron and Steel Company (POSCO) Holdings with ticker symbol (KOSE:A005490) which was foreign listed (at the time) announced (on 04 June 2009) acquiring Tshipi é Ntle Manganese Mining (Proprietary) Limited. POSCO acquired 11.36% stake for $34.3 mill;
- Sumitomo Corporation (TSE:8053) which was foreign listed (at the time) announced (on 11 January and 16 July 2009) acquiring Assore Limited. Sumitomo acquired 10.45% and 3.14% stake respectively for $499.98 mill and $30.09 mill respectively;
- Merafe Resources Limited (JSE:MRF) announced (on 04 May 2005) acquiring Wonderkop Chrome Operation. Merafe acquired 50% stake for $38.77 mill;
- Murray & Roberts (M&R) Holdings Limited (JSE:MUR) announced (on 22 July 2004) acquiring Murray & Roberts Cementation Co. Ltd. M&R acquired 20.87% stake for $3 mill;
- Randgold & Exploration Company Limited (RNG) with ticker symbol (JSE:RNG) announced (on 21 August 2003) acquiring Free State Development and Investment Corporation Limited. Randgold acquired 55.1% stake for $1.84 mill;
- MC Mining Limited (ASX:MCM) announced (on 15 August 2002) acquiring SA Mineral Resources Corp Ltd. MC Mining acquired 34.5% stake for $1.85 mill;
- Anglo American plc (AAL) with ticker symbol (LSE:AAL) announced (on 15 August 2002) acquiring Anglovaal Mining Limited. Anglo American acquired 34.9% stake for $1,6 bill; and
- Tharisa plc (THA) with ticker symbol (JSE:THA) announced (on 15 August 2002) acquiring Tharisa Minerals (Pty) Ltd. Tharisa plc acquired 20% stake for $304.81 mill.

*Table 4-3: TV and weight descriptive statistics of DMM sample portfolio*

| DMM Sample | Mean | Std Error | Median | Std Dev | Sum | Count | Conf Level (95%) |
|---|---|---|---|---|---|---|---|
| T Value | 235,78 | 144,6 | 34,3 | 479,58 | 2593,58 | 11 | 322,19 |
| Weight | 34,88 | 7,34 | 34,5 | 24,34 | 383,65 | 11 | 16,35 |

On Table 4-3, the standard error value of $144.6 mill suggests variability in the estimate of the mean. The median indicates that half of the data points are below $34.3mill and the other half are above. Since the median was much lower than the mean, it suggests the presence of high outliers. The high outlier was the AAL 15 August 2002 transaction. The Anglo American TV resulted in a high standard deviation of $479.58 mill, indicating that the data points are widely dispersed. A confidence level of $322.19mill suggests the margin of error was large, likely due to the small sample size and the high variability in the data. The smaller sample was the reason bootstrapping technique was used in order to plot the 5% and 95% graph on the 11 day CAAR weighted figure.

Table 4-4 presents AAR%, t-statistics of AAR% and CAAR% for a DMM sample over a range of days before and after an event as day 0.

*Table 4-4: AAR and CAAR for DMM sample portfolio*

| | DMM | | | |
|---|---|---|---|---|
| Period (days) | AAR% | t-stats of AAR% | Window Period | CAAR% |
| 10 | 1,38 | 0,17 | | |
| 9 | 1,36 | 0,17 | | |
| 8 | 0,88 | 0,11 | | |
| 7 | 1,71 | 0,21 | | |
| 6 | 0,58 | 0,07 | | |
| 5 | 2,41 | 0,3 | | |
| 4 | 1,8 | 0,22 | | |

| | | | | |
|---|---|---|---|---|
| 3 | 0,69 | 0,09 | (0;+10) | 13,57 |
| 2 | 0,77 | 0,1 | (0;+5) | 7,11 |
| 1 | 1,45 | 0,18 | (0;+2) | 2,77 |
| 0 | 0,56 | 0,07 | (0;0) | 0,56 |
| -1 | 1,45 | 0,18 | (-2;0) | 3,11 |
| -2 | 1,1 | 0,14 | (-5;0) | 4,71 |
| -3 | 0,69 | 0,09 | (-5;+5) | 12,38 |
| -4 | 0,41 | 0,05 | (-10;+10) | 26,9 |
| -5 | 1,07 | 0,13 | (-250;+10) | 27,6 |
| -6 | 2,81 | 0,35 | (-250;0) | 14,59 |
| -7 | 1,1 | 0,14 | (-250;-11) | 1,26 |
| -8 | -0,16 | -0,02 | | |
| -9 | 2,44 | 0,3 | | |
| -10 | 1,87 | 0,23 | | |

There are several positive AARs before the event (e.g., 1.87% on day -10 and 1.45% on day -1), indicating potential anticipation of the event. After the event, AARs remain mostly positive, suggesting that the event may have been perceived positively by the market.

CAAR% shows a large cumulative effect across different window periods. For instance, the CAAR% for (0;+10) was 13.57%, suggesting a significant impact of the event over the 10-day post-event period. Most of the t-statistics are relatively low, implying that the abnormal returns in this period are not statistically significant. This suggests that the abnormal returns might not be robust evidence of a strong market reaction to the event.

In summary, the data suggests that while there were positive abnormal returns both before and after the event, the statistical significance was low, which means the market response to the event may not be definitive. However, the CAAR% over time show a strong positive trend, indicating some degree of market optimism or impact.

**CAAR weighted:** The graph in Figure 4-3 shows the CAAR% over an 11-day event window for a DMM Sample. The graph illustrates an event study examining how stocks within this sample performed around the M&A event.

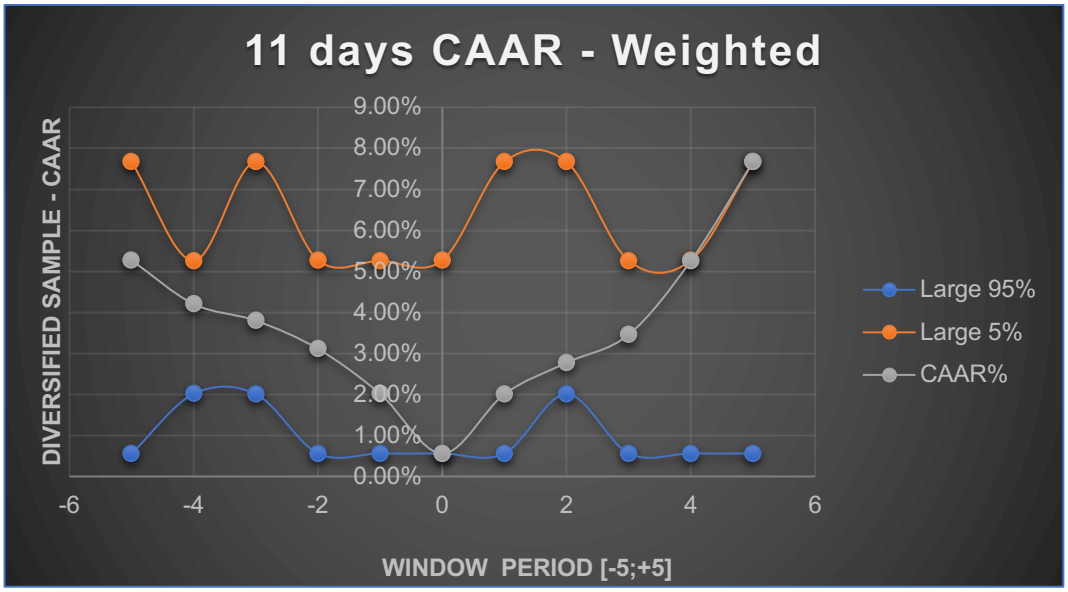


*Figure 4-3: 11 days CAAR (weighted): DMM sample.*

CAAR% starts below 5% before the event and increases gradually, peaking around day +6 at approximately 8%. This suggests a positive market reaction over time. Large 95% values remain close to 0% throughout the window, indicating that even the lower bound of the confidence interval was flat, suggesting limited risk of negative abnormal returns during this period. Large 5% band at the 5% confidence level, shows the potential upper range of abnormal returns. The line was higher, consistently between 6-8%, indicating the potential for larger abnormal returns but with higher uncertainty.

CAAR% shows an upward trend from approximately day 0 onwards, peaking on day +6. This suggests that the event had a positive impact on the stocks in the sample, and cumulative returns increased significantly. The 95% and 5% confidence bands remain separated by a considerable margin, indicating some level of variability but generally positive returns. The orange line consistently suggests higher possible returns compared to the grey CAAR line, while the blue line suggests low negative risk. In summary, this graph reflects a positive abnormal performance by the diversified sample, with increasing returns after the event and limited risk of negative returns.

**Solver:** In framing an M&A strategy of diversified commodities portfolio, excel solver can be introduced to minimise the standard deviation, which was the same thing as minimizing the variance. The solver results on Table 4-5 represent the weights (shareholding) assigned to different transactions (labelled as a.1 through a.9) in a portfolio. The sum of these weights equals 1, indicating a fully allocated portfolio to derive diversified shareholder return.

*Table 4-5: Investment allocation using solver on DMM portfolio*

| Transaction | Announcement Date | label | Weight |
|---|---|---|---|
| ASX:ORN | 1/3/2017 | a.1 | 0,21 |
| JSE:NPH | 7/1/2012 | a.2 | 0,14 |
| KOSE:A005490 | 6/4/2009 | a.3 | 0,14 |
| TSE:8053 | 7/16/2007 | a.4 | 0,06 |
| TSE:8053 | 1/11/2007 | a.5 | 0,02 |
| JSE:MRF | 5/4/2005 | a.6 | 0,13 |
| JSE:MUR | 7/22/2004 | a.7 | 0,12 |
| JSE:RNG | 8/21/2003 | a.8 | 0,02 |
| ASX:MCM | 8/15/2002 | a.9 | 0,16 |
| | | Total | 1 |

**Diversification** - The portfolio was diversified across nine transactions, with the highest weight of 21% allocated to asset a.1 and the lowest weight of 2% allocated to assets a.5 and a.8. Solver allocated zero to the transactions dated 2022/02/16 & 2002/03/12, therefore, the transactions were then eliminated from the analysis and solver results adjusted.

**Portfolio Strategy** - The weights suggest a strategy where some transactions are given more importance (e.g., a.1, a.2, a.3, a.9), while others are given relatively smaller allocations (e.g., a.4, a.5, a.8). This was be based on factors such as expected returns, risk and other constraints defined in the solver.

**Risk Management** - Allocating weights to different transactions helps in spreading risk. For instance, having only 6% in a.4 and 2% in a.5 and a.8 may indicate that these assets are either more volatile or less expected to perform, thus lowering their impact on the overall portfolio.

**Optimization Objective** - The exact objective for using solver include maximizing returns, minimizing risk and achieving a target return with the lowest possible risk. The weights reflect the optimal solution found by solver given the constraints and the objective. In summary, these weights determine how much capital to allocate to each asset to achieve the desired balance between risk and return. Overall, the results from Excel Solver provide a quantitative foundation for making informed allocation decisions.

**Correlation:** In finance and investment, correlation was a statistic that quantifies the degree to which two securities move in relation to each other. It was often used to measure the relationship between the performance of a stock and a benchmark index, like the S&P 500. Correlation plays a key role in diversification, which was the strategy of reducing certain risks by investing in assets that do not move in tandem. It measures the strength of the relationship between two variables and was represented by the correlation coefficient, which ranges from -1.0 to 1.0. A correlation coefficient of 1 indicates a perfect positive correlation, meaning that as one security's value increases or decreases, the other moves in the same direction by the same proportion. Conversely, a coefficient of -1 indicates a perfect negative correlation, meaning the two assets move in opposite directions. A correlation of zero suggests no linear relationship between the two variables (Hayes et al., 2024).

An empirical investigation of the effects of M&A on firms profitability study by Ferrer (2012), analysing return on assets (ROA), return on equity (ROE) and M&A variables, found that ROA and ROE had a moderate negative correlation. M&A variable had no correlation with either ROA and ROE. The

correlation matrix results show that the variables correlate 1 against each other.

Wilson and Vencatachellum (2016) found that M&As in Africa are highly correlated with Asia and South America with correlation coefficients of 0.85 and 0.87. From the literature in Chapter 2, Mpofu (2010) findings indicate that the FTSE/JSE index has a statistically significant correlation with the macroeconomic variables analyzed, aligning with similar studies conducted in other countries. Additionally, the mining index, specific to mining countries, showed a non-significant positive correlation with the FTSE/JSE index.

In following the different authors and how analysing the application of different variable correlate with each other, this study did a correlation analysis only on the full sample (see appendix 7). Tharisa plc (16/2/2024) transaction positively low correlated with Anglo American (12/03/2002) transaction with correlation coefficient of 0.1 and negatively low correlated with both POSCO Holdings (04/06/2009) and Merafe Resources (04/05/2005) transactions with correlation coefficient of -0.13 and -0.12 respectively. Other transaction had insignificant correlation and some correlated with transactions outside the DMM sample group.

**Covariance:** In Table 4-6, the diagonal elements of the matrix (e.g., a.1 with a.1, a.2 with a.2, etc.) represent the variance of each transaction. This was because covariance with itself was just the variance. Larger variances suggest that an asset's returns fluctuate more widely.

Off-diagonal elements (covariance between different assets) represent the covariance between pairs of different transactions. For example, covariance between a.1 and a.2: $-1.80\times10^{-07}$ indicate a slight tendency to move in opposite directions. Transaction a.3 and a.4 have a covariance $4.53\times10^{-54}$, indicating a tendency to move together. The signs (+/-) and magnitudes of these values help in understanding how pairs of assets move together:

- Positive covariance: For example, a.3 and a.5 have a positive covariance of $2.17\times10^{-42}$, suggesting they generally move in the same direction; and
- Negative covariance: For example, a.1 and a.2 have a negative covariance of $-1.80\times10^{-7}$ indicating that when one goes up, the other tends to go down.

The magnitude of the covariance values indicates the strength of the relationship. Smaller magnitudes (closer to zero) suggest weaker relationships between the transaction returns. Larger magnitudes suggest stronger relationships. However, to compare the strength of relationships, one would typically look at the correlation matrix, which normalizes these values.

*Table 4-6: DMM covariance matrix*

| | **a.1** | **a.2** | **a.3** | **a.4** | **a.5** | **a.6** | **a.7** | **a.8** | **a.9** |
|---|---|---|---|---|---|---|---|---|---|
| **a.1** | 9,80E-09 | -1,80E-07 | -2,67E-07 | -4,59E-08 | 3,41E-07 | -1,46E-07 | 3,26E-07 | -7,35E-07 | -1,04E-08 |
| **a.2** | -1,80E-07 | 5,04E-04 | 7,06E-06 | -6,38E-05 | -4,69E-05 | -1,32E-04 | 1,57E-05 | -4,18E-05 | -1,06E-06 |
| **a.3** | -2,67E-07 | 7,06E-06 | 1,48E-03 | 4,53E-05 | 2,17E-04 | 1,26E-04 | -2,98E-05 | 1,64E-04 | -9,45E-06 |
| **a.4** | -4,59E-08 | -6,38E-05 | 4,53E-05 | 1,51E-03 | 1,72E-04 | 6,33E-05 | 5,37E-05 | 1,06E-04 | 3,32E-06 |
| **a.5** | 3,41E-07 | -4,69E-05 | 2,17E-04 | 1,72E-04 | 2,81E-03 | 6,94E-05 | -1,57E-05 | 2,30E-04 | 8,15E-06 |
| **a.6** | -1,46E-07 | -1,32E-04 | 1,26E-04 | 6,33E-05 | 6,94E-05 | 1,15E-03 | 2,25E-05 | 3,06E-04 | -6,11E-06 |
| **a.7** | 3,26E-07 | 1,57E-05 | -2,98E-05 | 5,37E-05 | -1,57E-05 | 2,25E-05 | 6,38E-04 | 8,65E-05 | 3,57E-06 |
| **a.8** | -7,35E-07 | -4,18E-05 | 1,64E-04 | 1,06E-04 | 2,30E-04 | 3,06E-04 | 8,65E-05 | 8,41E-03 | -1,32E-05 |
| **a.9** | -1,04E-08 | -1,06E-06 | -9,45E-06 | 3,32E-06 | 8,15E-06 | -6,11E-06 | 3,57E-06 | -1,32E-05 | 7,95E-06 |

Most covariances observed in this matrix are quite small (many in the range of $10^{-09}$ to $10^{-05}$), indicating weak relationships between the transaction

pairs. Transactions like a.8 and a.6 have a higher covariance $3.06 \times 10^{-04}$. compared to other transactions, indicating that the RandGold and Merafe transactions have stronger relationship.

Transactions with low or negative covariances can be combined to create diversified portfolios that reduce overall risk. Since many of these values are small or negative, it suggests that a portfolio including these transactions might benefit from diversification. Portfolio Construction: Analyzing this covariance matrix can help in using EF to constructing portfolios that optimize the trade-off between risk and return, aiming to achieve a diversified portfolio with reduced risk.

**Efficient frontier:** The provided graph in Figure 4-4 shows an EF for a diversified portfolio. The EF was a concept from modern portfolio theory (MPT) and represents the set of optimal portfolios that offer the highest expected return for a given level of risk (standard deviation) or the lowest risk for a given level of expected return.

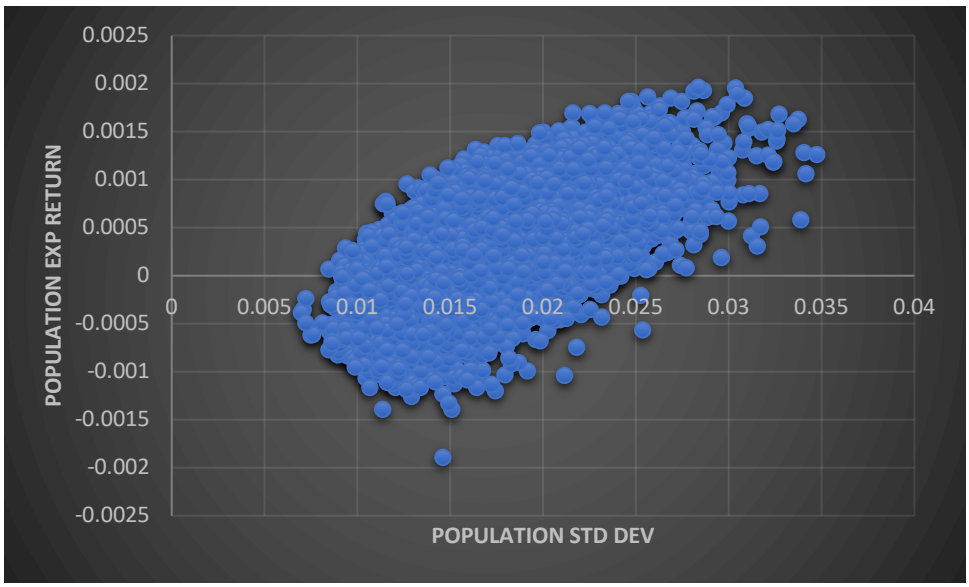


*Figure 4-4: DMM efficient frontier.*

X-axis represents the risk of the portfolio measured by the standard deviation of the portfolio returns. Higher values indicate higher risk as Y-axis represents the expected return of the portfolio. Higher values indicate higher expected returns. Each point on the scatter plot on the graph represents a different portfolio with a unique combination of transactions. The position of each point shows the trade-off between the portfolio risk (standard deviation) and its expected return.

The EF was typically an upward-sloping curve. Portfolios to the right have higher risk and, generally, higher expected returns. Portfolios to the left have lower risk and, generally, lower expected returns. The curve was formed by the outer boundary of the scatter plot, indicating the best possible returns for each level of risk.

The plot shows many possible portfolios created from a mix of random transactions. The dense clustering of points suggests a wide variety of portfolios with different risk-return profiles. The points near the top-left edge of the cloud represent portfolios that are more efficient because they offer higher expected returns for lower levels of risk.

Portfolios that lie on the efficient frontier are considered optimal. For a given level of risk, no other portfolio offers a higher expected return. For a given level of expected return, no other portfolio offers a lower risk.

A practical use may involve a MRH or investor using the DMM EF to select commodities or target company based on their risk tolerance. A risk-averse investor might choose a portfolio near the left end of the frontier (lower risk and return). For example, an acquiring company can acquire assets with a standard deviation of 0.006 to 0.0125 with an expected ROI of 0.0001 to 0.0008. An acquirer seeking a balanced acquisition can acquire assets with 0.015 to 0.02 standard deviation with an expected ROI of between 0.001 to 0.0015. A risk-tolerant investor might choose a portfolio near the right end of the frontier (higher risk and return). For example, the acquiring company

can acquire risky assets with a standard deviation of 0.025 to 0.03 and expecting to make 0.0015 to 0.002 return.

### 4.2.3 Gold

The Gold sample data present descriptive statistics data points for shareholders that only want to hold gold assets. Transactions that made it into this sample group include:

- Alternative Investment Market listed (AIM), Oriole Resources plc (ORR) with ticker symbol (AIM:ORR) announced (on 31/03/2021) acquiring Bibemi and Wapouzé projects. Oriole acquired 51% stake for $1,56mill;
- Galane Gold Ltd. (GG) with ticker symbol (TSXV:GG) announced (on 29/04/2015) acquiring Galaxy Gold Mining Ltd. Galane acquired 78% stake for $11 mill.
- DRDGOLD Limited (DRD) with ticker symbol (L:DRD) announced (on 18/03/2014) acquiring Ergo Mining Operations (Proprietary) Limited. DRDGOLD acquired 26% stake for $8.61mill;
- Harmony Gold Mining Company Limited (HAR) with ticker (JSE:HAR) announced (on 19/03/2010) acquiring Harmony Gold Mining Company Limited (JSE:HAR). Harmony acquired 26% stake for $399.15mill;
- Kairos Minerals Limited (ASX:KAI) announced (on 03/12/2009) acquiring Raptor Minerals (Pty) Ltd. Kairos acquired 90% stake for $0,53mill;
- Eastern Platinum Limited (ELR) with ticker symbol (TSX:ELR) announced (on 22/08/2006) acquiring Afriminerals Holdings (Pty) Ltd. Eastern Platinum acquired 49% stake for $8.81mill;
- Harmony Gold Mining Company Limited (JSE:HAR) announced (on 20/06/2006) acquiring Village Main Reef Gold Mining Co. Harmony acquired 37.8% stake for $0.46mill;

- Harmony Gold Mining Company Limited (JSE:HAR) announced (on 09/03/2006) acquiring Western Areas Limited. Harmony acquired 24.25% stake for $1,534.79mill; and
- Harmony Gold Mining Company Limited (JSE:HAR) announced (on 15/04/2004) acquiring Avgold Ltd. Harmony acquired 46.3% stake for $332.98 mill.

Transactions by Harmony dominated the gold sample, meaning the results in Table 4-7 were heavily influenced by one company.

*Table 4-7: TV and weight descriptive statistics of gold sample group*

| Gold Sample | Mean | Std Error | Median | Std Dev | Sum | Count | Conf Level (95%) |
|---|---|---|---|---|---|---|---|
| TV | 255,32 | 168,3 | 8,81 | 504,89 | 2297,89 | 9 | 388,1 |
| Weight | 47,59 | 7,74 | 46,3 | 23,22 | 428,35 | 9 | 17,84 |

The sample has a high mean and a high variability indicated by the large standard deviation and standard error. The median of $8.81mill was very low compared the mean, suggesting that the distribution might be skewed (possibly with a few large TV pulling the mean upwards). The wide confidence interval of $388.1mill indicates that there was significant uncertainty about the population mean based on this sample.

The weights median of $46.3% and mean of 47.59% are closer to each other, suggesting that the weights are symmetrically distributed. The 95% confidence level was narrower for Weight (17.84%) compared to TV, indicating more precision in estimating the population mean weight.

In summary, the Gold Sample shows significant variability in both TV and Weight, with TV showing particularly high dispersion and uncertainty. The

sample weight, while still variable, was more consistent and predictable based on this data.

**AAR and CAAR:** Table 4-8 presents AAR%, t-statistics of AAR% and CAAR% for a Gold sample over a range of days before and after an event.

*Table 4-8: AAR and CAAR for gold sample portfolio*

| | Gold Sample | | | |
|---|---|---|---|---|
| Period (days) | AAR% | t-stats of AAR% | Window Period | CAAR% |
| 10 | 0,1 | 0,07 | | |
| 9 | 0,1 | 0,08 | | |
| 8 | 0,17 | 0,12 | | |
| 7 | 0,12 | 0,09 | | |
| 6 | 0,1 | 0,08 | | |
| 5 | 0,13 | 0,1 | | |
| 4 | 0,03 | 0,02 | | |
| 3 | 0,09 | 0,07 | (0;+10) | 1,17 |
| 2 | 0,09 | 0,07 | (0;+5) | 0,57 |
| 1 | 0,17 | 0,13 | (0;+2) | 0,32 |
| 0 | 0,05 | 0,04 | (0;0) | 0,05 |
| -1 | 0,12 | 0,09 | (-2;0) | 0,45 |
| -2 | 0,27 | 0,2 | (-5;0) | 0,88 |
| -3 | 0,19 | 0,14 | (-5;+5) | 1,4 |
| -4 | 0,13 | 0,1 | (-10;+10) | 2,7 |
| -5 | 0,1 | 0,08 | (-250;+10) | 2,85 |
| -6 | 0,13 | 0,09 | (-250;0) | 1,74 |
| -7 | 0,18 | 0,13 | (-250;-11) | 0,14 |
| -8 | 0,12 | 0,09 | | |
| -9 | 0,16 | 0,12 | | |
| -10 | 0,12 | 0,09 | | |

AAR% shows relatively small abnormal returns throughout the period. Most AAR% values range between 0.1% to 0.27%. The t-stats of AAR% are also low values, suggesting that these abnormal returns are not statistically significant in most periods. Before the event (Period -10 to 0) AAR% was observed to be relatively stable, ranging from 0.1% to 0.27%. The highest

AAR% before the event was at period -2 (0.27%). T-stats of AAR% are low (mostly below 0.2), indicating weak statistical significance for the all abnormal returns. After the event (Period 0 to 10), AAR% remains low as it ranges from 0.03% to 0.17%. The highest AAR% post-event was at period 1 (0.17%). T-stats of AAR% remain low, indicating that there was no strong evidence of statistically significant abnormal returns after the event.

CAAR for the 11-day period after the event (from day 0 to day 10) was 1.17%. This suggests a slight positive impact on the sample overall, but given the low t-stats, this may not be statistically significant. CAAR for the 6-day period after the event (from day 0 to day 5) was 0.57%, indicating a modest gain in this shorter window. CAAR% was just 0.05%, showing minimal abnormal returns on the actual event day. CAAR for the 6-day period leading up to the event (from day -5 to day 0) was 0.88%. This suggests that any positive abnormal returns before the event might have contributed more to the overall CAAR% than the post-event returns. CAAR over the entire 21-day window period (from day -10 to day +10) was 2.7%, indicating a modest overall impact.

In summary, the data suggests that the Gold Sample experiences modest positive abnormal returns surrounding the event. However, the small t-statistics imply that these returns are not statistically significant, indicating that the event might not have had a strong or clear impact on the sample's performance. CAAR% show slight gains, with the most significant increase happening before the event, which could suggest some level of anticipation or speculation leading up to the event.

**CAAR weighted:** The graph in Figure 4-5 shows the CAAR% over an 11-day event window for a Gold sample. The graph illustrates how stocks within this sample performed around the M&A event.

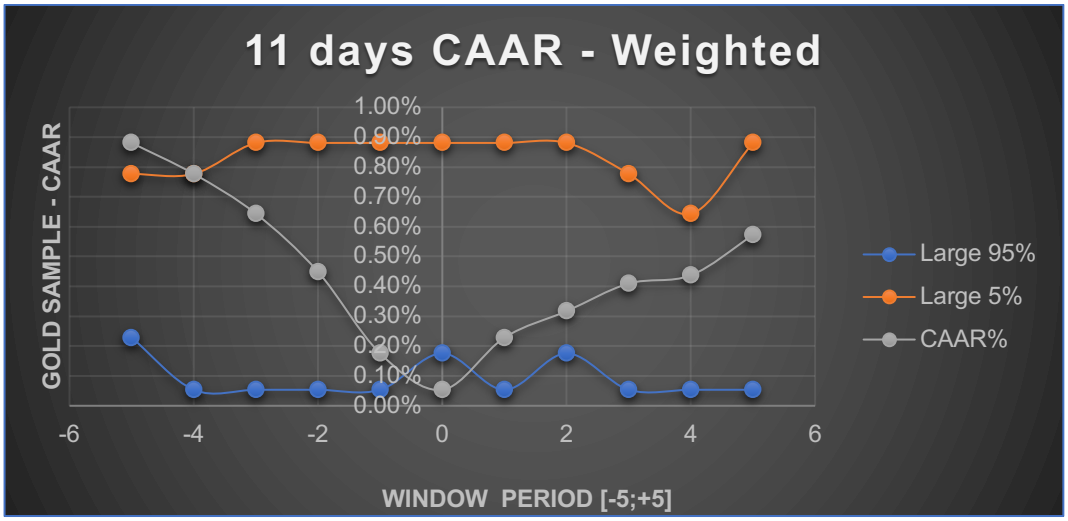


*Figure 4-5: 11 days CAAR (weighted): gold sample.*

Pre-event period (Days -5 to 0), CAAR% was observed to start around 0.9% at day -5 and gradually decreases as it approaches the event day. By day 0, the CAAR% was below 0.1%. This suggests a decline in the abnormal returns leading up to the event. The Large 95% was consistently below 0.1% throughout the entire pre-event period, indicating that at the 95% confidence level, the returns are quite low. The Large 5% was steady around 0.9%, which indicates that at the upper 5% confidence level, returns remain relatively consistent.

Post-event period (Days 0 to +5), CAAR% shows a gradual increase from day 0 to day 5, ending around 0.5%. This indicates a modest recovery in the cumulative abnormal returns after the event. The Large 95% remains very low, close to 0%, indicating that there was low confidence in significant abnormal returns at the lower end. The Large 5% decreases slightly post-event but remains above 0.8%, suggesting that at the upper bound, the cumulative abnormal returns do not drop drastically.

In summary, the graph suggests that the Gold sample experiences a decline in cumulative abnormal returns leading up to the event (from day -5 to day 0). However, after the event (from day 0 to day +5), there was a slight

recovery, though the overall CAAR% remains modest. The confidence intervals suggest that there was low statistical confidence in significant abnormal returns at the lower bound (95%), while at the upper bound (5%), the CAAR% remains relatively stable and positive. This could indicate that while there are some positive effects post-event, they are not overwhelmingly strong or statistically significant across the entire sample.

**Solver:** The solver results on Table 4-9 present the optimum shareholding assigned to different transactions (labelled as b.1 through b.8) in a portfolio. The sum of these weights equals 1, indicating a fully allocated portfolio to derive single commodity shareholder return.

*Table 4-9: Investment allocation using solver on gold portfolio*

| Transaction | Announcement Date | Label | Weight |
|---|---|---|---|
| AIM:ORR | 3/31/2021 | b.1 | 0,22 |
| TSXV:GG | 4/29/2015 | b.2 | 0,11 |
| NYSE:DRD | 3/18/2014 | b.3 | 0,11 |
| JSE:HAR | 3/19/2010 | b.4 | 0,11 |
| ASX:KAI | 12/3/2009 | b.5 | 0,11 |
| TSX:ELR | 8/22/2006 | b.6 | 0,11 |
| JSE:HAR | 6/20/2006 | b.7 | 0,11 |
| JSE:HAR | 4/15/2004 | b.8 | 0,11 |
| | | Total | 1 |

Gold focus – some investors or shareholders believe that companies that focus on one commodity tend to perform. Investors or MRH that are gold focus would acquire gold assets that have the potential to create value.

Portfolio Strategy - The weights suggest a strategy where some transactions are given more importance such as Oriole Resources with weighting of 0.22, while others are given equal allocations of 0.11 based on expected returns, risk and other constraints defined in the solver.

Risk Management - Solver gave zero on transaction Harmony 09/03/2006 transaction. Therefore, this transaction was removed and Solver results adjusted to Table 4-9 output.

**Covariance:** Transaction b.1 and b.2 have a covariance of -6.4 x $e^{-06}$. This small negative covariance indicates a very slight inverse relationship between b.1 and b.2. Covariance between b.4 and b.4 was 0.002847, which was a diagonal element, so it's the variance of b.4. A higher value indicates that b.4 has relatively high variability in its returns. Transactions b.6 and b.1 covariance was -3.1 x $e^{-05}$ have a negative covariance that suggests a tendency to move in opposite directions, although the relationship was weak. Transactions b.8 and b.3 covariance was 9.95 x $e^{-06}$ with a small positive covariance indicating a slight positive relationship between b.8 and b.3. Gold covariance matrix in Table 4-10 can be used in portfolio construction, as combining assets with low or negative covariances can reduce overall portfolio risk through diversification. Whereas, the observation of assets with high and positive covariance can make up a single commodity portfolio.

*Table 4-10: Gold covariance matrix*

| | *b.1* | *b.2* | *b.3* | *b.4* | *b.5* | *b.6* | *b.7* | *b.8* |
|---|---|---|---|---|---|---|---|---|
| b.1 | 0,000104 | -6,4E-06 | 1,29E-06 | 4,92E-07 | 1,91E-07 | -3,1E-05 | -2,2E-05 | 4,25E-05 |
| b.2 | -6,4E-06 | 0,014451 | -1,8E-06 | 0,000331 | 1,5E-06 | 6,89E-06 | 0,000217 | 5,6E-05 |
| b.3 | 1,29E-06 | -1,8E-06 | 3,69E-06 | -4,7E-06 | 4,08E-08 | 8,72E-06 | -6,3E-07 | 9,95E-06 |
| b.4 | 4,92E-07 | 0,000331 | -4,7E-06 | 0,002847 | 6,79E-07 | -0,00025 | -0,00016 | -9,4E-05 |
| b.5 | 1,91E-07 | 1,5E-06 | 4,08E-08 | 6,79E-07 | 6,67E-08 | -2,4E-07 | -2,2E-07 | 1,35E-06 |
| b.6 | -3,1E-05 | 6,89E-06 | 8,72E-06 | -0,00025 | -2,4E-07 | 0,001426 | 4,59E-06 | -2,5E-05 |
| b.7 | -2,2E-05 | 0,000217 | -6,3E-07 | -0,00016 | -2,2E-07 | 4,59E-06 | 0,006061 | -0,00011 |
| b.8 | 4,25E-05 | 5,6E-05 | 9,95E-06 | -9,4E-05 | 1,35E-06 | -2,5E-05 | -0,00011 | 0,002129 |

The covariances in this matrix are small in general, which could suggest that the assets are not strongly correlated with each other. This was supported

by the low correlation values on the corelation matrix in appendix 7. Understanding these covariances can help mining companies in M&A.

**Efficient frontier:** Figure 4-6 shows an EF for a gold focus portfolio.

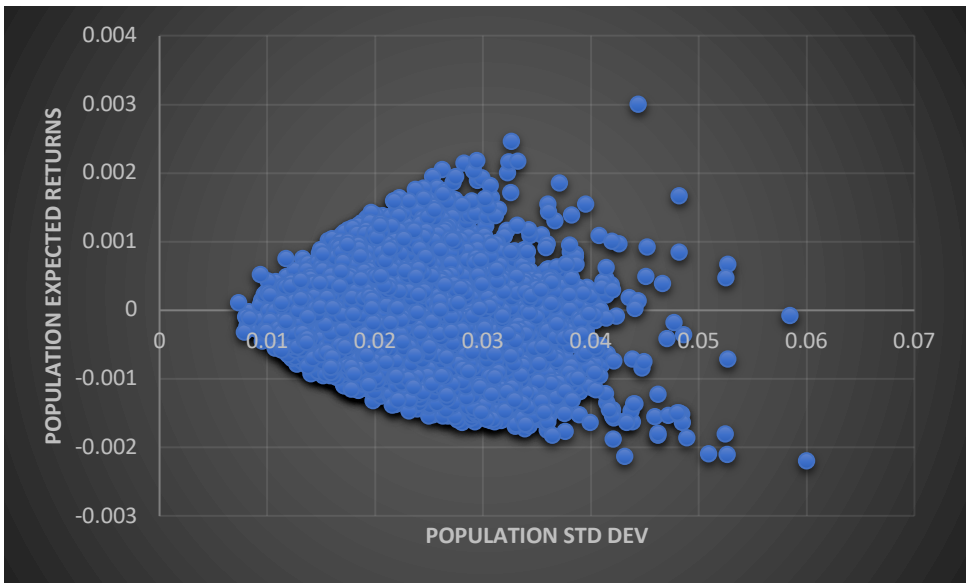


*Figure 4-6: Gold efficient frontier.*

The bulk of portfolios are clustered around lower levels of standard deviation (0.01 to 0.03), indicating that most portfolios are designed to have relatively low risk. As the standard deviation increases rightward along the X-axis, the number of portfolios decreases, showing that fewer portfolios are targeting higher risk levels.

MRH looking to optimize portfolio holding would aim to choose portfolios that lie on the EF, balancing their desired level of risk with the maximum potential return. Conservative investors might prefer portfolios on the lower-left. For example, an acquiring company can acquire assets that have a standard deviation of 0.01 with an expected ROI of 0.0005. An acquirer seeking a balanced acquisition can acquire assets with 0.02 standard deviation with an expected ROI of 0.0015. An aggressive investor might choose a portfolio near the right end of the frontier (higher risk and return).

For example, the acquiring company can acquire risky assets with a standard deviation of 0.03 and expecting to generate 0.002 ROI. All the assets that lie below the EF X-axis are value destruction assets.

### 4.2.4 PMM

The PMM sample data present descriptive statistics data points on Table 4-11 for shareholders that are seeking PMM assets. Transactions that made it into this sample group include:

- Raubex Group Limited (JSE:RBX) announced (on 31/01/2022) acquiring Bauba Resources Limited. Raubex acquired 24.7% stake for $435.19 mill;
- Northam Platinum Holdings Limited (JSE:NPH) announced (on 07/12/2021) acquiring Royal Bafokeng Platinum Limited. Northam acquired 2.19% stake for $1,037.71 mill;
- Northam Platinum Holdings Limited (JSE:NPH) announced (on 09/11/2021) acquiring Royal Bafokeng Platinum Limited. Northam acquired 32.76% stake for $16,305.88 mill;
- Kazera Global plc (AIM:KZG) announced (on 31/01/2022) acquiring Deep Blue Minerals Pty Ltd. Kazera acquired 90% stake for $0.66 mill;
- Jubilee Metals Group PLC (JLP) with ticker symbol (AIM:JLP) announced (on 18/11/2014) acquiring Pollux Investment Holdings Proprietary Limited. Jubilee acquired 7.5% stake for $6.2 mill;
- Jubilee Metals Group PLC (AIM:JLP) announced (on 03/11/2014) acquiring Jubilee Tailings and Treatment Company Proprietary Limited. Jubilee acquired 25% stake for $0.61 mill;
- Platinum Group Metals Ltd. (TSX:PTM) announced (on 09/11/2011) acquiring Mnombo Wethu Consultants CC. PTM acquired 49.9% stake for $1.2 mill;

- Petra Diamonds Limited (LSE:PDL) announced (on 18/11/2009) acquiring Cullinan. Petra Diamond acquired 37% stake for $117.28 mill;
- Northam Platinum Holdings Limited (JSE:NPH) announced (on 30/06/2009) acquiring Pandora Joint Venture. Northam acquired 7.5% stake for $65 mill;
- Gold Fields Limited (GFI) with ticker symbol (JSE:GFI) announced (on 30/06/2009) acquiring Sibanye Stillwater Limited. Gold Fields acquired 15% stake for $6,140 mill;
- Investec Group (INL) with ticker symbol (JSE:INL) announced (on 22/01/2009) acquiring JCI Limited. Investec acquired 4.72% stake for $11.9 mill;
- Platinum Group Metals Ltd. (TSX:PTM) announced (on 22/01/2009) acquiring Western Bushveld Joint Venture, Projects 1 and 3. PTM acquired 37% stake for $785.5 mill;
- Eastern Platinum Limited (TSX:ELR) announced (on 06/03/2007) acquiring Barplats Investments Limited. ELR acquired 26% stake for $209.63 mill; and
- Eastern Platinum Limited (TSX:ELR) announced (on 01/03/2007) acquiring Barplats Investments Limited. ELR acquired 5% stake for $246.55 mill.

*Table 4-11: TV and weight descriptive statistics of PMM sample group*

| PMM Sample | Mean | Std Error | Median | Std Dev | Sum | Count | Conf Level (95%) |
|---|---|---|---|---|---|---|---|
| TV | 1690,99 | 1118,45 | 117,28 | 4331,74 | 25364,78 | 15 | 2398,84 |
| Weight | 24,62 | 6,03 | 24,7 | 23,35 | 369,27 | 15 | 12,93 |

Since $117.28 mill TV median was much lower than the mean, this suggests that there may be outliers pulling the mean upwards. The median weight was 24.7% which was close to the mean indicates that the data is relatively symmetrically distributed with regard to weight. The standard deviation for TV was $4331.74 mill, indicating a high level of dispersion from the mean. This supports the earlier observation that there are outliers or high variability in the TV data. The outlier transaction on this sample was the Northam Platinum 32.76% acquisition of Royal Bafokeng Platinum for $16,305.88 mill.

**AAR and CAAR:** Table 4-12 presents AAR%, t-statistics of AAR% and CAAR% for PMM sample. The data in Table 4-12 indicates that the PMM sample experienced positive abnormal returns both before and after the event, contributing to a significant CAAR% over time.

*Table 4-12: AAR and CAAR for PMM sample portfolio*

| | PMM Sample | | | |
|---|---|---|---|---|
| Period (days) | AAR% | t-stats of AAR% | Window Period | CAAR% |
| 10 | 0,8 | 0,15 | | |
| 9 | 0,89 | 0,17 | | |
| 8 | 0,85 | 0,16 | | |
| 7 | 0,72 | 0,14 | | |
| 6 | 0,77 | 0,15 | | |
| 5 | 0,85 | 0,16 | | |
| 4 | 0,67 | 0,13 | | |
| 3 | 0,87 | 0,17 | (0;+10) | 9 |
| 2 | 0,94 | 0,18 | (0;+5) | 4,96 |
| 1 | 0,8 | 0,15 | (0;+2) | 2,56 |
| 0 | 0,82 | 0,16 | (0;0) | 0,82 |
| -1 | 0,73 | 0,14 | (-2;0) | 2,5 |
| -2 | 0,95 | 0,18 | (-5;0) | 5,16 |
| -3 | 0,99 | 0,19 | (-5;+5) | 9,3 |
| -4 | 0,79 | 0,15 | (-10;+10) | 17,29 |
| -5 | 0,89 | 0,17 | (-250;+10) | 18,12 |
| -6 | 0,79 | 0,15 | (-250;0) | 9,94 |
| -7 | 0,8 | 0,15 | (-250;-11) | 0,82 |

| | | |
|---|---|---|
| -8 | 0,82 | 0,16 |
| -9 | 0,75 | 0,14 |
| -10 | 0,8 | 0,15 |

AAR% was generally positive and ranges from 0.73% to 0.99% before the event, indicating that the sample experienced positive abnormal returns in the days leading up to the event. The t-statistics are relatively low (around 0.14 to 0.19), suggesting that while these returns are positive, they may not be statistically significant. The AAR% on the event day was 0.82%, with a t-statistic of 0.16. This positive abnormal return suggests that the event had a favourable impact on the sample returns, though the significance remains modest.

The CAAR% grows progressively larger over time, with a maximum value of 18.12% for the window period (-250;+10), indicating significant cumulative abnormal returns when considering a long time horizon. T-statistics for post-event days are similar to the pre-event period, indicating consistent, though modest, significance. However, the relatively low t-statistics suggest that while the returns are positive, even if the statistical significance was limited.

**CAAR weighted:** Figure 4-7 shows CAAR% over an 11-day window period surrounding precious metals transactions events.

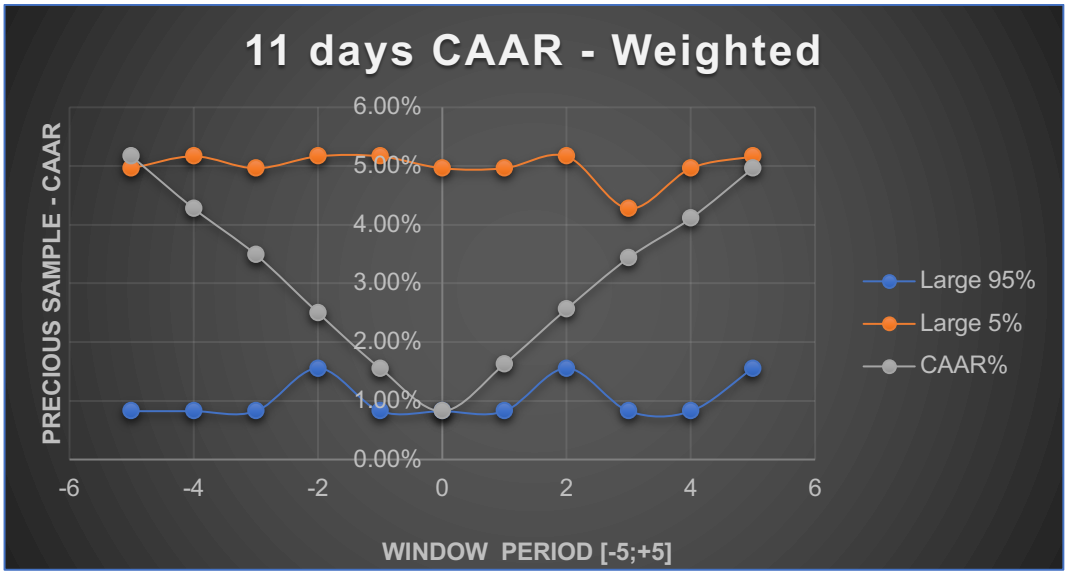


*Figure 4-7: 11 days CAAR (weighted): PMM sample.*

CAAR% decreases as it approaches the event day, indicating a minor decline in cumulative returns leading up to the event. The orange line remains consistent at around 5%, suggesting that the top-performing 5% of the sample maintain a high level of abnormal returns. CAAR% increases post event day back to 5% after 5 days. Suggesting a market correction to levels prior the event. For existing, shareholders, the graph suggests no value created. However, for new shareholders that bought shares a day before the event, the graph suggests significant value created.

**Solver:** Table 4-13 shows solver results for a weighted portfolio of PMM sample. The table present the optimum shareholding assigned to different transactions (labelled as c.1 to c.10) in the PMM portfolio. The sum of these weights equals 1, indicating a fully allocated portfolio to derive precious metal shareholder return.

*Table 4-13: Investment allocation using solver on PMM portfolio*

| Transaction | Announcement Date | Label | Weight |
|---|---|---|---|

| | | | |
|---|---|---|---|
| JSE:NPH | 11/9/2021 | c.1 | 0,01 |
| AIM:JLP | 11/18/2014 | c.2 | 0,12 |
| AIM:JLP | 11/3/2014 | c.3 | 0,12 |
| AIM:JLP | 1/25/2013 | c.4 | 0,11 |
| TSX:PTM | 11/9/2011 | c.5 | 0,11 |
| JSE:NPH | 6/30/2009 | c.6 | 0,10 |
| JSE:INL | 1/22/2009 | c.7 | 0,10 |
| TSX:PTM | 9/2/2008 | c.8 | 0,11 |
| TSX:ELR | 3/6/2007 | c.9 | 0,11 |
| TSX:ELR | 3/1/2007 | c.10 | 0,11 |
| | | Total | 1 |

The exact objective for using solver include maximizing returns, minimizing risk and achieving a target return with the lowest possible risk. The weights reflect the optimal solution found by solver given the constraints and the objective. These weights determine how much capital to allocate to each asset on the PMM sample to achieve the desired balance between risk and return.

In managing risk, solver returned a zero result on transaction 2022/01/31, 2021/12/07, 2020/06/04, 2009/11/18 and 2009/03/17. Therefore, these transactions were removed and solver results adjusted to results presented on Table 4-14. Allocating weights 1% in c.1 may indicate that the asset was either more volatile or less expected to perform, thus lowering its impact on the PMM portfolio. The rest of the transactions received a weighting allocation ranging from 10 to a maximum of 12%. According to solver, the 2014 Jubilee transactions had the best balance of risk to the expected return. Overall, the results from excel solver provide a quantitative foundation for making informed allocation decisions.

**Covariance:** By understanding how different assets returns move in relation to each other, a portfolio can be constructed that optimizes returns while minimizing risk within the PMM sample. In this context, these covariances could be used to assess the overall risk profile of a portfolio containing transactions c1 to c10 in Table 4-14.

*Table 4-14: PMM covariance matrix*

| | *c.1* | *c.2* | *c.3* | *c.4* | *c.5* | *c.6* | *c.7* | *c.7* | *c.8* | *c.9* |
|---|---|---|---|---|---|---|---|---|---|---|
| c.1 | 0,024752 | 4,2E-05 | 2,91E-05 | 0,0005 | 0,000179 | 0,000543 | -0,00022 | -0,00037 | 0,000467 | 0,000184 |
| c.2 | 4,2E-05 | 1,64E-05 | 1,39E-06 | -3,8E-06 | -2,4E-06 | 3,51E-05 | -2,1E-06 | 1,93E-05 | 1,03E-05 | -7,2E-06 |
| c.3 | 2,91E-05 | 1,39E-06 | 1,85E-05 | 2,29E-05 | 5,28E-06 | 7,99E-06 | 3,99E-06 | -1,9E-06 | -3,3E-06 | -1,8E-05 |
| c.4 | 0,0005 | -3,8E-06 | 2,29E-05 | 0,002058 | -2,9E-05 | -0,00011 | 4,55E-05 | -8,5E-05 | -0,00021 | 6,34E-05 |
| c.5 | 0,000179 | -2,4E-06 | 5,28E-06 | -2,9E-05 | 0,001152 | -0,00021 | 6,26E-05 | -0,00013 | 0,000102 | -5,7E-05 |
| c.6 | 0,000543 | 3,51E-05 | 7,99E-06 | -0,00011 | -0,00021 | 0,004491 | 4,17E-05 | -6,2E-05 | -0,00013 | 0,000152 |
| c.7 | -0,00022 | -2,1E-06 | 3,99E-06 | 4,55E-05 | 6,26E-05 | 4,17E-05 | 0,002513 | 4,62E-05 | -1,7E-05 | -0,00011 |
| c.8 | -0,00037 | 1,93E-05 | -1,9E-06 | -8,5E-05 | -0,00013 | -6,2E-05 | 4,62E-05 | 0,001692 | -2,8E-05 | 4,1E-05 |
| c.9 | 0,000467 | 1,03E-05 | -3,3E-06 | -0,00021 | 0,000102 | -0,00013 | -1,7E-05 | -2,8E-05 | 0,00123 | -0,00016 |
| c.10 | 0,000184 | -7,2E-06 | -1,8E-05 | 6,34E-05 | -5,7E-05 | 0,000152 | -0,00011 | 4,1E-05 | -0,00016 | 0,001237 |

The value 0.024752 at the intersection (c.1, c.1) represents the variance of the returns for transaction c.1, c.1 (0.024752). This was the variance of transaction c.1, indicating how much the returns of this transaction deviate from its mean. The covariance between transactions c.1 and c.2 was very small (4,2 x $e^{-05}$) but positive, indicating a very weak positive relationship between these returns. The covariance between transactions c.1 and c.6 was positive and larger (0,000543) compared to other covariances, suggesting that these two transactions returns tend to move together more strongly than with others. The covariance between transactions c.7 and c.8 was positive but small (4.62 x $e^{-05}$), suggesting a slight positive relationship between these two returns.

**Efficient frontier:** Investors typically want to choose a portfolio on the EF because it offers the most efficient trade-off between risk and return. Figure

4-8 illustrates the trade-off between risk (volatility) and return for different portfolio configurations within the PMM assets.

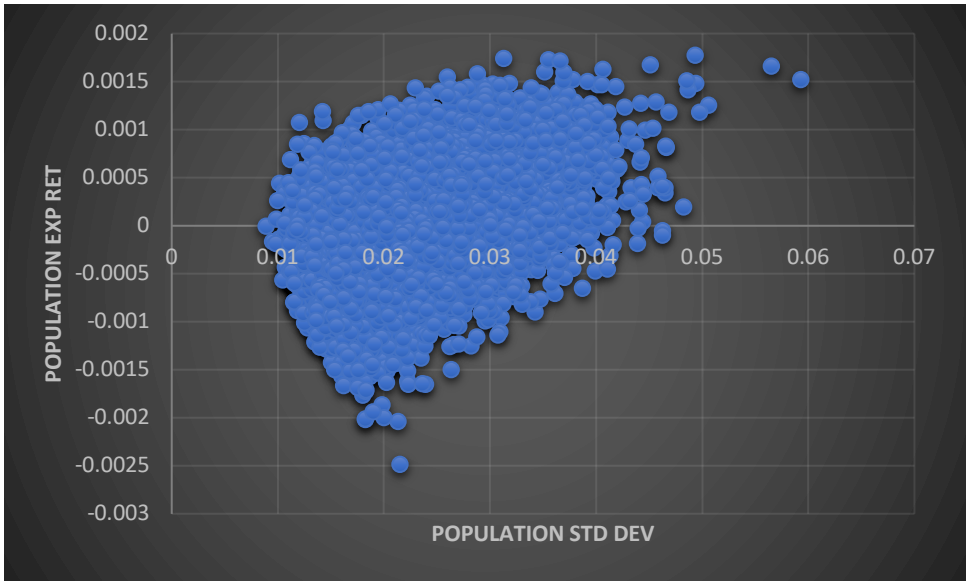


*Figure 4-8: PMM efficient frontier.*

Depending on the investor risk tolerance, MRH might choose different points along the EF. Risk-averse investors might choose a portfolio with lower standard deviation (i.e. 0.015) and slightly lower returns (i.e. 0.0005), while risk-seeking investors might aim for higher returns at the cost of increased volatility (i.e. 0.0015). Assets that have a standard deviation of 0.02 and an ROI of -0.002 would result in loses for shareholders.

### 4.2.5 Steel

The Steel sample data present descriptive statistics data points on Table 4-15 for shareholders that are seeking steel assets. Transactions that made it into this sample group include:

- Afrimat Limited (JSE:AFT) announced (on 15/08/2017) acquiring 40% Diro Iron Ore (Pty) Ltd and 40% in Diro Manganese (Pty) Ltd. Afrimat acquired 40% stake for $44 mill;

- Jubilee Metals Group PLC (AIM:JLP) announced (on 04/05/2010) acquiring Jubilee Smelting and Refining (Pty) Ltd. Jubilee acquired 70% stake for $10 mill;
- Acerinox, S.A. (ACX) with ticker symbol (BME:ACX) announced (on 13/05/2005) acquiring Columbus Stainless (Pty) Ltd. Acerinox acquired 12% stake for $60.81 mill; and
- Acerinox, S.A. (BME:ACX) announced (on 25/07/2001) acquiring Columbus Stainless (Pty) Ltd. Acerinox acquired 64% stake for $230.55 mill.

It was important to note that the Afrimat transaction and the Jubilee transaction involved iron ore and manganese commodities which are used in the value chain of steel making.

*Table 4-15: TV and weight descriptive statistics of steel sample group*

| Steel Sample | Mean | Std Error | Median | Std Dev | Sum | Count | Conf Level (95%) |
|---|---|---|---|---|---|---|---|
| TV | 86,34 | 49,22 | 52,41 | 98,44 | 345,36 | 4 | 156,63 |
| Weight | 46,5 | 13,2 | 52 | 26,4 | 186 | 4 | 42,01 |

The average value for TV was $86.34mill and a TV standard error of $49.22mill which results in a relative standard error of 57%. This shows high variability in the sample M&A deal value sizes. The sample has a with a weighting average of 46.5% and a weight standard error of 13.2%. This results in a relative standard error of 28%. This shows a low variability in M&A deal stake being bought by acquiring companies. A TV standard deviation of $98.44mill results in a relative standard deviation of 114%, which suggests that the data points are widely spread out, with high variability around the mean.

TV confidence interval of $156.63mill was wide, showing uncertainty in the mean estimate. The weight mean less variability compared that of TV, as indicated by the smaller standard deviation of 26.4% and standard error of 13.2%. The confidence interval of 42% was also narrower, reflecting more certainty in the mean estimate.

**AAR and CAAR:** The steel sample in Table 4-16 presents AAR%, t-statistics of AAR% and CAAR% for Steel sample over a range of days before and after an event.

*Table 4-16: AAR and CAAR for steel sample portfolio*

| | Steel Sample | | | |
|---|---|---|---|---|
| Period (days) | AAR% | t-stats of AAR% | Window Period | CAAR% |
| 10 | 10,67 | 0,07 | | |
| 9 | 7,8 | 0,05 | | |
| 8 | 9,66 | 0,06 | | |
| 7 | 11,1 | 0,07 | | |
| 6 | 23,01 | 0,14 | | |
| 5 | 18,63 | 0,12 | | |
| 4 | 17,06 | 0,11 | | |
| 3 | 13,68 | 0,09 | (0;+10) | 145,4 |
| 2 | 15,77 | 0,1 | (0;+5) | 83,17 |
| 1 | 14,46 | 0,09 | (0;+2) | 33,79 |
| 0 | 3,56 | 0,02 | (0;0) | 3,56 |
| -1 | 11,07 | 0,07 | (-2;0) | 28,44 |
| -2 | 13,81 | 0,09 | (-5;0) | 65,74 |
| -3 | 10,56 | 0,07 | (-5;+5) | 145,4 |
| -4 | 16,46 | 0,1 | (-10;+10) | 276,2 |
| -5 | 10,27 | 0,06 | (-250;+10) | 290,5 |
| -6 | 2,94 | 0,02 | (-250;0) | 148,6 |
| -7 | 12,84 | 0,08 | (-250;-11) | 14,25 |
| -8 | 17,91 | 0,11 | | |
| -9 | 20,8 | 0,13 | | |
| -10 | 14,13 | 0,09 | | |

The steel sample shows consistently positive AAR% values across most days, suggesting that the steel sample tends to outperform the expected returns, particularly after the event (day 0). CAAR% values are quite high, for larger window periods like (0;+10) and (-10;+10). For example, the CAAR% for the window period (0;+10) was 145.4%, and for (-10;+10) it was 276.2%. T-stats values are relatively low across the board, indicating that AR values are positive, but may not be statistically significant. A t-statistic below 2 typically suggests that the result was not statistically significant at the conventional 5% level.

**CAAR weighted: t**he performance of CAAR% was plotted and presented in Figure 4-9 to give a picture of cumulative returns few days before the event and few days after the event.

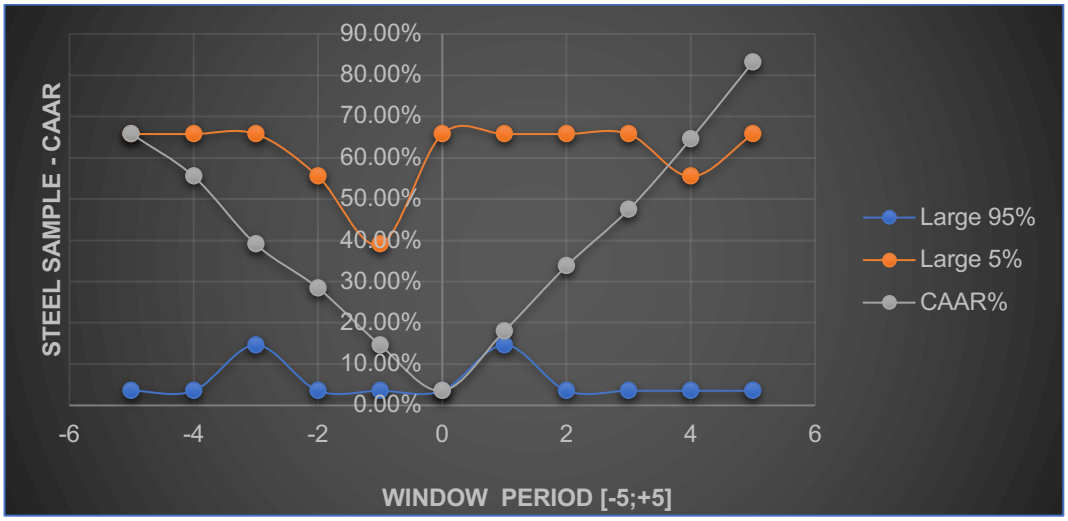


*Figure 4-9: 11 days CAAR (weighted): steel sample.*

CAAR% line in Figure 4-9 shows a significant positive reaction to the event, with the steel sample generating substantial cumulative abnormal returns post-event. The relatively stable and high position of the Large 5% line, suggests that even under worst-case scenarios within the 5% confidence level, CAAR% remains positive and significant. This indicates a strong underlying performance for the steel sample. The low and stable Large 95%

line indicate that extreme positive deviations from the AAR are limited, possibly due to market constraints.

**Solver**: Table 4-17 shows solver results for four transactions. The table present the optimum shareholding assigned to different transactions (labelled as d.1 to d.4) in the steel portfolio.

*Table 4-17: Investment allocation using solver on steel portfolio*

| Transaction | Announcement Date | Label | Weight |
|---|---|---|---|
| JSE:AFT | 8/15/2017 | d1 | 0,25 |
| AIM:JLP | 5/4/2010 | d2 | 0,25 |
| BME:ACX | 5/13/2005 | d3 | 0,25 |
| BME:ACX | 7/25/2001 | d4 | 0,25 |
| | | Total | 1 |

The exact objective for using solver on the steel sample include maximising returns, minimising risk and achieving a target return with the lowest possible risk. The weights reflect the optimal solution found by solver given the constraints and the objective of the steel sample. Solver allocated 25% weighting to each of the transaction and the sum of these weights equals 1, indicating a fully allocated portfolio to derive shareholder return.

Plotting an EF of transactions in Table 4-17 results in a scatter plot graph that suggest a high risk and a negative return on investment yielding portfolio. This was due to transaction d2 and d4 which had negative share prices on WP (-259;+10). Therefore, this necessitated running solver again (see Solver 2 below).

**Covariance:** Table 4-18 shows a covariance matrix for four variables in the steel sample.

*Table 4-18: Steel covariance matrix*

| | d.1 | d.2 | d.3 | d.4 |
|---|---|---|---|---|
| d.1 | 0,001044 | 0,184285 | -0,00012 | 0,443063 |
| d.2 | 0,184285 | 2921,461 | -0,11315 | -131,96 |
| d.3 | -0,00012 | -0,11315 | 0,002552 | -0,25191 |
| d.4 | 0,443063 | -131,96 | -0,25191 | 369408,3 |

The variance for d.2 (2921.461) and d.4 (369408.3) was significantly higher than the variance for d.1 and d.3, indicating that d.2 and d.4 have more variability in their data compared to the other variables. The covariance between d.4 and d.1 (0.443063) was positive and relatively large, indicating a strong relationship between these two variables. However, the covariance between d.2 and d.4 (-131.96) was negative and significant in magnitude, indicating a strong inverse relationship. The negative covariance values (e.g., d.3 with d.2 and d.4 with d.3) suggest that these variables tend to move in opposite directions. A positive and significant covariance between d.1 and d.4 could indicate that if d.1 increases, d.4 was likely to increase as well. Conversely, the negative covariance between d.2 and d.4 suggests that as d.2 increases, d.4 tends to decrease.

**Solver 2:** Table 21 shows solver results for 2 transactions. The table present the optimum shareholding assigned to transactions (labelled as d.1 and d.3) in the steel portfolio after removing transaction d2 and d4.

*Table 4-19: Investment allocation using solver on steel portfolio*

| | Weight |
|---|---|
| d.1 | 0,7 |
| d.3 | 0,3 |
| Total | 1 |

In Table 4-19 was a minimum variance weights, which give a total of 100%. After optimizing solver inputs to give weights on transactions with positive stock prices on WP (-259;+10), solver gave zero on transactions 2010/05/04 and 2001/07/25. Therefore removed. This allowed the EF to yield a graph in Figure 4-10 that allows investment. A scenario like this gives an indication that solver can be used in combination with EF to yield better results.

**Efficient Frontier:** The graph in Figure 4-10 shows an EF (a) for the two transactions in Table 4-19. Two variables always produce a line graph on an EF.

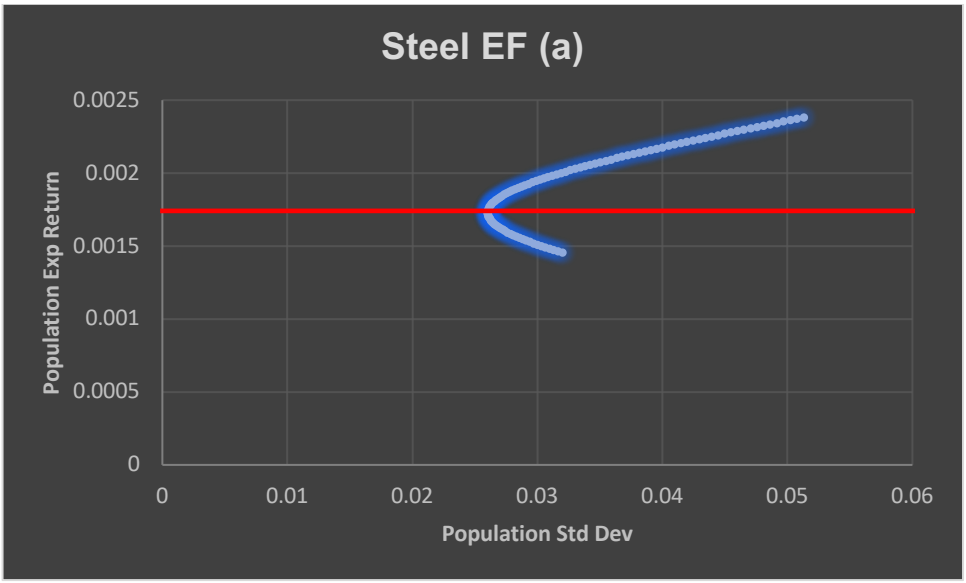


*Figure 4-10: steel efficient frontier (a).*

In Figure 4-10, transaction performance above the red line was efficient and transactions below the red line was not efficient. An EF graph that only shows efficient transactions can then be constructed by selecting a array to start where the frontier starts to be efficient. This was at a standard deviation of 0.0265 and population expected return of 0.00175. The resulting graph was presented on Figure 4-11 steel EF (b).

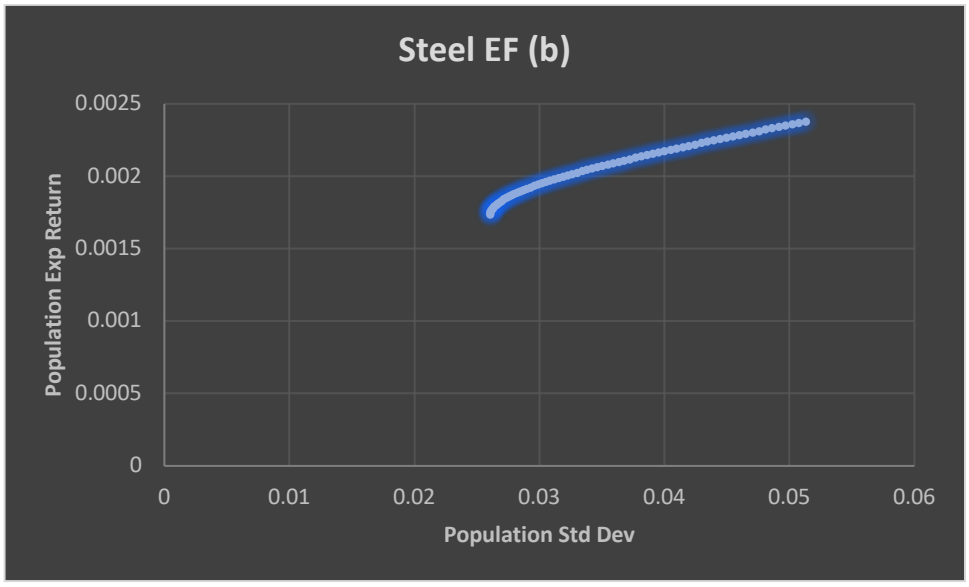


*Figure 4-11: steel efficient frontier (b).*

Conservative acquires might prefer to acquire assets that have a standard deviation of 0.03 with an expected ROI of 0.002. An acquirer seeking a moderate risk acquisition can acquire assets with 0.04 standard deviation with an expected ROI of 0.0022. An aggressive acquirer can acquire risky assets with a standard deviation of 0.05 and expecting to generate 0.0024 ROI. The advantage of Figure 4-11 was that it allows acquirers to only selected value creating assets.

### 4.2.6 JSELBEEB

The JSELBEEB sample data present descriptive statistics data points on Table 4-20 for shareholders that want transformational growth. Transactions that made it into this sample group include:

- Tharisa plc (JSE:THA) announced (on 16/02/2022) acquiring Tharisa Minerals (Pty) Ltd. Tharisa acquired 20% stake for $304.81 mill;
- Raubex Group Limited (JSE:RBX) announced (on 31/03/2021) acquiring Bauba Resources Limited. Raubex acquired 24.7% stake for $435.19 mill;

- Afrimat Limited (JSE:AFT) announced (on 15/08/2017) acquiring 40% Diro Iron Ore (Pty) Ltd and 40% in Diro Manganese (Pty) Ltd. Afrimat acquired 40% stake for $44 mill;
- Northam Platinum Holdings Limited (JSE:NPH) announced (on 01/07/2012) acquiring Northam Chrome Producers Proprietary Limited. Northam acquired 70% stake for $10 mill;
- Harmony Gold Mining Company Limited (JSE:HAR) announced (on 19/03/2010) acquiring Doornkop South Project. Harmony acquired 26% stake for $399.15 mill;
- Northam Platinum Holdings Limited (JSE:NPH) announced (on 30/06/2009) acquiring Pandora Joint Venture. Northam acquired 7.5% stake for $65 mill;
- Gold Fields Limited (JSE:GFI) announced (on 30/06/2009) acquiring Sibanye Stillwater Limited. Gold Fields acquired 15% stake for $6,140 mill;
- Investec Group (JSE:INL) announced (on 22/01/2009) acquiring JCI Limited. Investec acquired 4.72% stake for $11.9 mill;
- Reunert Limited (RLO) with ticker (JSE:RLO) announced (on 30/09/2008) acquiring ATC (Pty) Limited. Reunet acquired 15% stake for $117 mill;
- Harmony Gold Mining Company Limited (JSE:HAR) announced (on 20/06/2006) acquiring Village Main Reef Gold Mining Co. Harmony acquired 37.8% stake for $0.46 mill;
- Harmony Gold Mining Company Limited (JSE:HAR) announced (on 09/03/2006) acquiring Western Areas Limited. Harmony acquired 24.25% stake for $1,534.79 mill;
- Merafe Resources Limited (JSE:MRF) announced (on 04 May 2005) acquiring Wonderkop Chrome Operation. Merafe acquired 50% stake for $38.77 mill; and
- Harmony Gold Mining Company Limited (JSE:HAR) announced (on 15/04/2004) acquiring Avgold Ltd. Harmony acquired 46.3% stake for $332.98 mill.

*Table 4-20: TV and weight descriptive statistics of JSELBEEB sample group*

| JSELBEEB Sample | Mean | Std Error | Median | Std Dev | Sum | Count | Conf Level (95%) |
|---|---|---|---|---|---|---|---|
| TV | 725,7 | 465,36 | 117 | 1677,87 | 9434,05 | 13 | 1013,93 |
| Weight | 36,05 | 8,77 | 26 | 29,1 | 396,57 | 11 | 19,55 |

The average value for TV was $725.7mill and a TV standard error of $465.36mill which results in a relative standard error of 64%. This shows high variability in the sample M&A deal value sizes. The sample has a with a weighting average of 36.05% and a weight standard error of 8.77%. This results in a relative standard error of 24%. This shows a low variability in M&A deal stake being bought by acquiring companies. A TV standard deviation of $1677.87mill results in a relative standard deviation of 231%, which suggests that the data points are widely spread out, with high variability around the mean.

TV confidence interval of $1,013.93mill was wide, showing uncertainty in the mean estimate. The mean weight was lower, with less variability compared to TV, as indicated by the smaller standard deviation and standard error. The confidence interval was also narrower, reflecting more certainty in the mean estimate.

**AAR and CAAR:** Table 4-21 table presents AAR% and CAAR% data for a sample JSELBEEB over a series of days relative to M&A announcement event.

*Table 4-21: AAR and CAAR for JSELBEEB sample portfolio*

| | JSELBEEB Sample |
|---|---|

| Period (days) | AAR% | t-stats of AAR% | Window Period | CAAR% |
|---|---|---|---|---|
| 10 | 0,89 | 0,15 | | |
| 9 | 0,93 | 0,16 | | |
| 8 | 0,95 | 0,16 | | |
| 7 | 0,9 | 0,15 | | |
| 6 | 0,9 | 0,15 | | |
| 5 | 0,92 | 0,16 | | |
| 4 | 0,85 | 0,15 | | |
| 3 | 0,91 | 0,16 | (0;+10) | 9,97 |
| 2 | 0,89 | 0,15 | (0;+5) | 5,4 |
| 1 | 0,94 | 0,16 | (0;+2) | 2,72 |
| 0 | 0,89 | 0,15 | (0;0) | 0,89 |
| -1 | 0,89 | 0,15 | (-2;0) | 2,79 |
| -2 | 1,01 | 0,17 | (-5;0) | 5,56 |
| -3 | 0,96 | 0,16 | (-5;+5) | 10,07 |
| -4 | 0,92 | 0,16 | (-10;+10) | 19,31 |
| -5 | 0,89 | 0,15 | (-250;+10) | 20,3 |
| -6 | 0,93 | 0,16 | (-250;0) | 11,23 |
| -7 | 0,96 | 0,16 | (-250;-11) | 1 |
| -8 | 0,93 | 0,16 | | |
| -9 | 0,95 | 0,16 | | |
| -10 | 0,9 | 0,15 | | |

AAR% values are consistent across the days, ranging from 0.85% to 1.01%. This suggests that, on average, the returns are slightly positive and relatively stable day by day, with slight fluctuations. T-stats of AAR%: These values are consistent, ranging from 0.15 to 0.17. This suggests that while there are abnormal returns, they may not be highly statistically significant due to the low t-statistic values.

For the period (0;+10), CAAR% was 9.97%. This means that over the 10 days following the event, the cumulative abnormal return was close to 10%. For the period (0;+5), CAAR% was 5.4%, indicating that half of the cumulative return seen over the 10-day window occurs within the first 5 days. CAAR% values increase as the window period lengthens, which was expected since the cumulative sum of positive AARs would grow over time. CAAR% for the (-250;+10) period was 20.3%, suggesting that when

considering a much larger time frame, the overall abnormal return was significant.

In summary, the Table 4-21 suggests that JSELBEEB sample consistently shows slight positive abnormal returns around the event period, leading to a noticeable cumulative impact over time. However, the t-statistics indicate that these abnormal returns might not be statistically significant, meaning that while the returns are positive, the evidence to suggest that these are significantly different from zero (i.e., not due to random chance) ws weak. The cumulative returns over different window periods provide insights into how the event may have affected the performance over time.

**CAAR weighted:** Figure 4-12 illustrates CAAR% over an 11-day window for JSELBEEB sample. It compares the weighted CAAR for two groups, Large 95% and Large 5%, along with the overall CAAR%.

Pre-event (-6 to -1) day, CAAR% shows a decreasing trend from about 4% down to about 2%, indicating a mild negative market sentiment in the days leading up to the event.

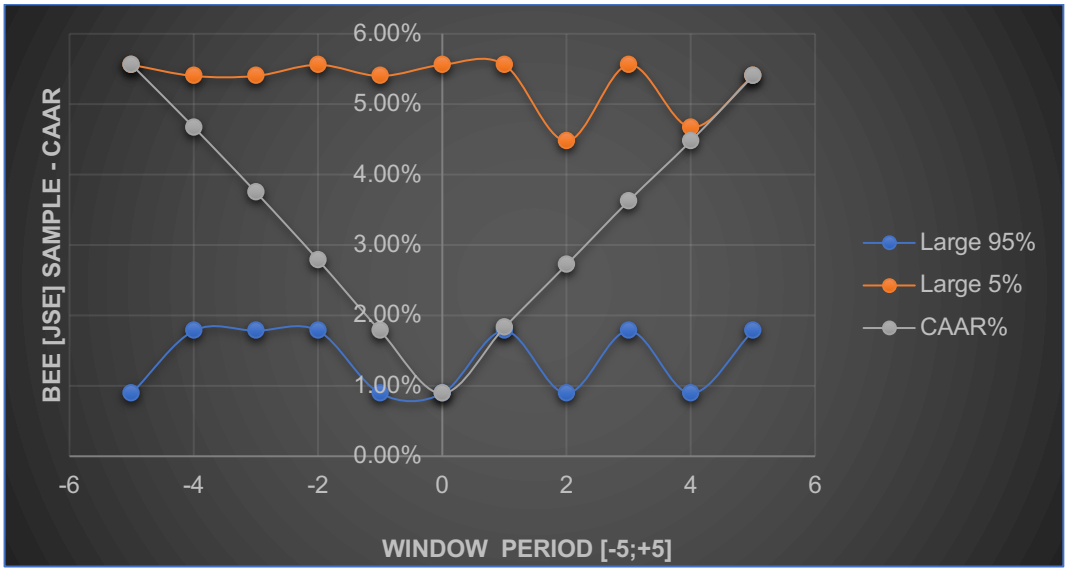


*Figure 4-12: 11 days CAAR: JSELBEEB sample.*

Large 95% shows little to no movement, staying around 1%, meaning that larger firms did not experience significant abnormal returns in the pre-event window. Large 5% stays relatively constant at around 5%, showing that the smaller firms have sustained abnormal returns that are significantly higher than the larger firms in this period.

CAAR% shows an upward trend post-event (+1 to +5), reaching about 5% by day 5, indicating a positive cumulative reaction to the event. Large 95% continue to show minimal change, staying flat around 1% throughout the post-event period, suggesting large companies are less affected by the event. Large 5% firms display more volatility but recover slightly by day 5, even though still staying below their pre-event levels.

Smaller companies exhibit higher abnormal returns but with greater volatility. Smaller companies have a stronger pre-event performance but experience a decline immediately around the event day. Larger companies show more stability but with much lower abnormal returns and remain relatively unaffected by both pre- and post-event. Overall, CAAR shows a positive recovery after the event, suggesting the market sentiment improves in the days following the event, leading to a cumulative positive reaction by day +5. This illustrates the market differential reaction to the event between smaller and larger companies within the JSELBEEB sample over an 11-day window.

### 4.2.7 1999 to 2022 Samples

Further analysis was done to look at performances of the 41 transactions when grouped as 1999 to 2004, 2005 to 2010, 2011 to 2016 and 2017 to 2022 transaction period and the analysis results are in appendix 1 to 4.

## 4.3 Depth of Analysis

Understanding why some M&A result in positive outcomes while others lead to underperformance offers a more refined perspective on corporate

strategy and value creation. These differing results can be influenced by various factors, including strategic fit, integration effectiveness, payment method (cash vs. stock) and market timing. For example, when the acquiring firm lacks a clear post-merger integration plan or overpays due to over-optimism, value destruction was more likely. In contrast, deals with strong synergies and complementary resources often deliver shareholder gains. As emphasized by Haleblian *et al*., (2009), exploring the contextual and executional variables surrounding M&A deals was key to explaining divergent outcomes.

## 4.4 Hypothesis Testing

As stated in section 3.5, rejection of CAAR in Table 4-22 at different critical levels indicates significance of CAAR and acceptance indicates insignificance of CAAR. This was presented in Table 4-22 which shows the analysis of various sample groups based on their Standard Error of Slope, CAAR t-statistics, Significance Level, and whether the null hypothesis (*H0*) was accepted or rejected.

*Table 4-22: Significance testing.*

| Sample Group | Standard Error of Slope | CAAR t-Statistics | Significance Level | Accept/Reject *H0* |
|---|---|---|---|---|
| Full sample | 15,93671 | 0,43 | Insignificant | Accept |
| Diversified Metals and Mining | 8,034493 | 0,46 | Insignificant | Accept |
| Gold | 1,346448 | 0,31 | Insignificant | Accept |
| Precious Metals and Minerals | 5,219194 | 0,54 | Insignificant | Accept |
| Steel | 159,2511 | 0,28 | Insignificant | Accept |
| JSE Listed BEE Buyers | 5,841182 | 0,52 | Insignificant | Accept |
| 2017 – 2022 | 3,358016 | 0,41 | Insignificant | Accept |
| 2011 - 2016 | 0,019159 | -0,87 | Insignificant | Accept |
| 2005 - 2010 | 6,715145 | 0,54 | Insignificant | Accept |
| 1999 - 2004 | 106,7245 | 0,31 | Insignificant | Accept |

Gold has a standard error of 1.35, which was quite low compared to "Steel" with a much larger error of 159.25, implying greater uncertainty in the Steel sector. In all the cases, the t-statistics was quite low (ranging from -0.87 to 0.54), indicating weak or no significant effect. Across all sample groups, there was no strong evidence of abnormal returns being significantly different from zero in any of the groups or time periods. The null hypothesis (*H0*), which assumes that there was no abnormal market return (CAAR = 0), was accepted across all groups. This further confirms that there are no significant abnormal returns in the different sectors or time periods analysed.

**International mining sector comparisons**: Studies in Canada, United States of America (U.S.) and Australia, which also have large mining sectors, have yielded similar results. For instance:

- André *et al.,* (2007) examined Canadian M&A and found that while some mining acquisitions showed short-term market optimism, long-term abnormal returns were often negligible or negative, indicating limited value creation;
- Baur (2014) examined how Australian gold mining companies stock returns are influenced by changes in gold prices. The study found that the average gold beta was around one but varies significantly over time, indicating that these firms stock returns are closely tied to gold price movements. This variability suggests that external factors, such as commodity price volatility, can significantly impact the performance of mining firms; And
- Ma et al. (2011) examined the post-acquisition performance of U.S. firms and found that acquirers tend to experience significantly negative buy-and-hold abnormal returns (BHAR) over 12, 24, and 36 months following the acquisition. This suggests that similar to findings in the Australian mining sector, certain mergers and acquisitions in non-mining industries can lead to unfavourable

outcomes for the acquiring firm shareholders. Further supporting inferences made in Table 4-22.

These parallels suggest that cyclical commodity prices, high integration costs, and political or regulatory uncertainty may consistently undermine M&A performance in the mining sector across countries.

**Comparisons with non-mining sectors**: In contrast, M&A activity in technology, healthcare, and consumer goods sectors in developed markets often shows more positive abnormal returns, particularly in the short-term.

- Moeller, Schlingemann, and Stulz (2005) reported significant positive abnormal returns for acquiring firms in high-growth sectors like tech and healthcare, driven by strategic innovation and market expansion potential; And
- Haleblian *et al.*, (2009) emphasized that industry-specific factors, such as innovation intensity and customer stickiness, lead to greater synergy realization in non-resource sectors.

These outcomes underscore the sector-specific nature of M&A performance, where capital-intensive and commodity-dependent sectors like mining struggle to deliver shareholder value, unlike their high-growth counterparts.

The lack of significant CAARs in SA mining M&As aligns with broader global patterns in resource-heavy industries. This reinforces the importance of industry context, integration strategy, and market conditions when interpreting M&A success. Future research may benefit from exploring non-mining sectors within South Africa to identify whether similar patterns of insignificance persist or if sectoral diversification enhances M&A outcomes.

**Statistical confidence**: Low statistical confidence in significant abnormal returns at the lower bound inferences in Table 4-22 raises critical concerns

about the robustness and reliability of the results. Type I or Type II errors can exist through — either falsely rejecting or failing to reject the null hypothesis. Low statistical confidence suggests that observed abnormal returns may be attributable to random market fluctuations rather than true economic effects from M&A activity. This undermines the strength of the conclusion and calls into question whether the positive or negative returns observed are genuinely meaningful or merely artifacts of sampling variability.

If confidence intervals for abnormal returns overlap with zero or demonstrate wide ranges, it becomes difficult to assert with conviction that M&A announcements systematically create or destroy shareholder value. The implications are particularly important for investors, policymakers, and managers that may rely on these findings to inform decision-making.

Reliance on event study methodologies assumes market efficiency and may not fully capture long-term value creation or destruction. Additionally, the use of CAARs may be sensitive to the chosen event window, which can either exaggerate or understate the true effects of M&A announcements. The use of bootstrap sampling methods also signifies the limitations of transactions in the sample groups used for the analysis. Other limitations could include survivorship bias in the sample selection, omitted variable bias, or failure to control for industry-specific shocks and macroeconomic conditions.

# 5 CONCLUSION AND RECOMMENDATIONS

The purpose of the study was to research whether mining M&A deals that took place between 1998 and 2022 in the mining industry, have benefited shareholders. The overall aim of this research was to put together a framework that can assist mining companies in concluding M&A transactions that would create value for shareholders. This was done by examining short-term effects on the acquiring MRH share price performance.

In the literature review, it was noted that enhancing share price performance was a primary objective of M&A activities. Most studies in this domain were found to be concentrated in the finance and business faculties, with a relatively smaller number conducted in the engineering faculty. While findings from finance and business management studies presented mixed results, suggesting that M&A transactions result in either a decrease, marginal increase, or no significant change in acquiring companies' share prices post-announcement, M&A transactions activity did not show or result in a steady long term decline as result. This stark difference in outcomes prompted the need for further exploration into the reasons behind this continued activity.

The literature review also emphasized the importance of both short-term and long-term event studies in evaluating the share price performance of acquiring companies. The present study aligned with this recommendation and discovered that shareholders of acquiring companies experienced no statistically significant positive CAAR during the 10-day window surrounding the announcement date.

## 5.1 Conclusion

Analysing the full sample, the 11 day CAAR weighted graph shows that the CAAR reduces leading up to event day and increases after the event day,

suggesting a positive impact of the event on the sample. The DMM 11 day CAAR graph showed positive market reaction that supurses 5% cumulation at day 4, showing value compared to previous performance. Since many of the values on the covariance matrix (Table 4-6) were small or negative, it suggests that a portfolio including these transactions might benefit from diversification.

The Gold 11 day CAAR graph showed a decline leading up to event day. However, after the event, the recovery was positively modest, which suggested slight value destruction in the short term. The 11 day CAAR graphs for PMM and JSELBEEB showed that market sentiment declined toward the event and simply corrected after the event. Therefore creating no value to shareholders.

The steel 11 day CAAR graph performed similar to the DMM CAAR graph. The steel sample experienced strong cumulative abnormal returns following the event, with market sentiment stronger than before the event. Steel transactions performed by listed companies are not frequent, which results in less sample availability.

Overall, the data suggests that there was no statistically significant abnormal market reaction in the samples or time periods under study. The null hypothesis, suggesting no abnormal return, was accepted consistently across all sample grouping and time periods. This implies that market events analysed in the sample groups do not lead to significant deviations from expected market performance.

As per the objective in section 2.8, the study outcomes indicate that buying MRHs did not generate statistically significant positive shareholder abnormal returns surrounding the announcement of M&A deals from 2008 to 2022. This was consistent the findings by Mabasa (2019), (McKinsey and Company, 2009) & Ward, (2007) (Birch, 2022)and Mushidzhi & Ward

(2004) that found that shareholders for acquirers do not earn statistically significant positive abnormal returns around the announcement.

## 5.2 Limitations of the findings

A notable limitation was that short-term event studies assess value created by analysing the performance of the share price few days before the transaction announcement and few days after. This limitation may rob insights into value created by transactions that made it into the Gold sample. For example, Harmony Gold Limited was the dominant company in the Gold sample with transactions dating back as far as 2004. As investments into the mining industry was a long-term game, some of the assets have life of mine greater than 20 years. In 2004 and 2005, the Gold price versus the US dollar averaged $431 (XAUSD). In October 30th, 2024, XAUSD reached $2786, which was a significant growth over the 20 years. The null hypothesis for the Gold sample was accepted as t-statistics showed positive but insignificant value created. However, the soaring of the gold price over the 20 year period suggest significant value for shareholders over the long-term.

An opportunity exists for researchers to research gold companies and the value created using a long-term event study methodology.

## 5.3 Recommendations

Based on the findings of the research and considering the recommended framework are as follows:

- Stock exchange listed MRH buyers can conduct event studies on the M&A transactions concluded in the past to validate whether the acquiring strategy creates value for shareholders;
- Descriptive statistics on the full sample in Table 3-1 showed a deal stake average of 35%. The standard error 3.92% resulted in a relative standard error of 11%, which shows a high accuracy of the

deal stake average. This means that most 41 M&A transactions studied employed the strategy of acquiring less than 50% shareholding in other mining companies to derive growth;

- A benchmark index to be used needs to be relevant to the geographic location of the mine;
- Bootstrapping techniques can be employed where there was limited or small sample. This assist in plotting and interpreting CAAR% for the sample;
- Solver excel tool can be used to: optimize portfolio of operating mines, guide the decision to unbundle assets and allocation of funds or equity investment;
- Corelation techniques can be used by diversified miners as it was a strategy of reducing certain risks by investing in assets that do not move in tandem;
- Covariance techniques can be used to identify transactions with low or negative covariances to combine and create diversified portfolios that reduce overall risk;
- Analyzing covariance matrix can help in constructing portfolios that optimize the trade-off between risk and return, aiming to achieve a diversified portfolio with reduced risk; and
- Efficient frontier can be used to choose the best return on investment target for a conservative to aggressive acquisition strategy. The advantage was that two or more variables or companies can be analysed using the EF.

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# APPENDIX

## Appendix 1: 1998 – 2004 Transactions

*Table A-1: TV and weight descriptive statistics of 1998 – 2004 sample group*

| 1998 – 2004 Sample | Mean | Std Error | Median | Std Dev | Sum | Count | Conf Level (95%) |
|---|---|---|---|---|---|---|---|
| T Value | 362,06 | 254,16 | 117,79 | 622,57 | 2172,38 | 6 | 653,35 |
| Weight | 6,46 | 3,22 | 3,58 | 7,89 | 38,75 | 6 | 8,28 |

*Table A-2: AAR and CAAR for 1998 - 2004 sample portfolio*

| | 1998 - 2004 Sample | | | |
|---|---|---|---|---|
| Period (days) | AAR% | t-stats of AAR% | Window Period | CAAR% |
| 10 | 8,79 | 0,08 | | |
| 9 | 6,41 | 0,06 | | |
| 8 | 8,68 | 0,08 | | |
| 7 | 9,87 | 0,09 | | |
| 6 | 13,45 | 0,13 | | |
| 5 | 15,82 | 0,15 | | |
| 4 | 11,08 | 0,1 | | |
| 3 | 10,36 | 0,1 | (0;+10) | 112,6 |
| 2 | 11,4 | 0,11 | (0;+5) | 65,4 |
| 1 | 12,11 | 0,11 | (0;+2) | 28,14 |
| 0 | 4,62 | 0,04 | (0;0) | 4,62 |
| -1 | 8,67 | 0,08 | (-2;0) | 22,68 |
| -2 | 9,39 | 0,09 | (-5;0) | 48,35 |
| -3 | 8,05 | 0,08 | (-5;+5) | 109,12 |
| -4 | 10,85 | 0,1 | (-10;+10) | 211,77 |
| -5 | 6,76 | 0,06 | (-250;+10) | 222,49 |
| -6 | 5,3 | 0,05 | (-250;0) | 114,51 |
| -7 | 10,44 | 0,1 | (-250;-11) | 10,27 |
| -8 | 10,66 | 0,1 | | |
| -9 | 16,42 | 0,15 | | |
| -10 | 12,62 | 0,12 | | |

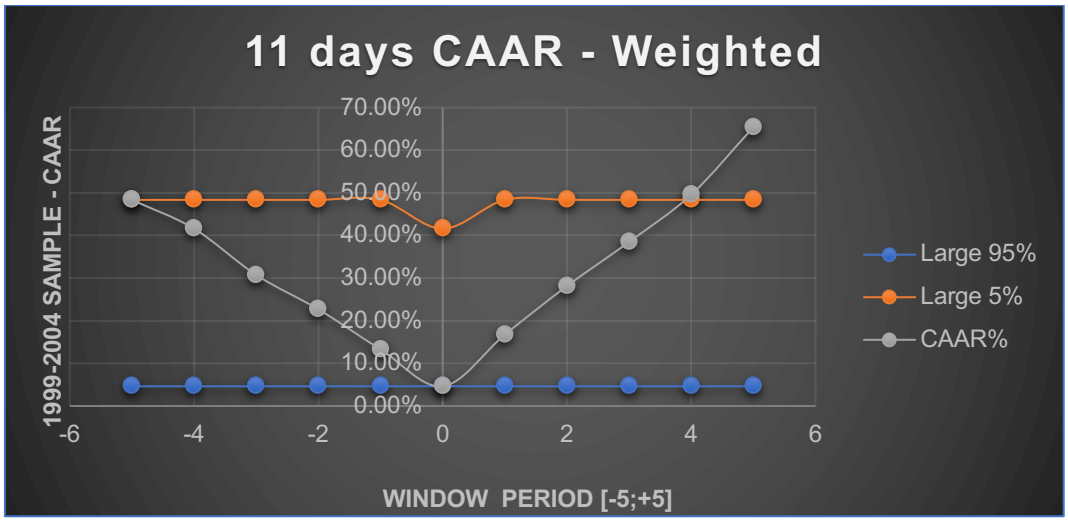


*Figure A-1: 11 days CAAR: 1998-2004 sample.*

## Appendix 2: 2005 – 2010 Transactions

*Table A-3: TV and weight descriptive statistics of 2005 – 2010 sample group*

| 2005 – 2010 Sample | Mean | Std Error | Median | Std Dev | Sum | Count | Conf Level (95%) |
|---|---|---|---|---|---|---|---|
| T Value | 516,03 | 307,37 | 62,91 | 1374,58 | 10320,54 | 20 | 643,32 |
| Weight | 30,06 | 5,57 | 25,13 | 24,9 | 601,22 | 20 | 11,65 |

*Table A-4: AAR and CAAR for 2005 - 2010 sample portfolio*

| | 2005 - 2010 Sample | | | |
|---|---|---|---|---|
| Period (days) | AAR% | t-stats of AAR% | Window Period | CAAR% |
| 10 | 1,01 | 0,15 | | |
| 9 | 1,31 | 0,19 | | |
| 8 | 0,17 | 0,02 | | |
| 7 | 0,93 | 0,14 | | |
| 6 | 2,27 | 0,34 | | |
| 5 | 1,13 | 0,17 | | |
| 4 | 2,62 | 0,39 | | |
| 3 | 0,52 | 0,08 | (0;+10) | 11,18 |
| 2 | 0,82 | 0,12 | (0;+5) | 5,51 |
| 1 | 0,65 | 0,1 | (0;+2) | 1,24 |
| 0 | -0,23 | -0,03 | (0;0) | -0,23 |
| -1 | 1,35 | 0,2 | (-2;0) | 2,82 |
| -2 | 1,69 | 0,25 | (-5;0) | 6,32 |
| -3 | 0,72 | 0,11 | (-5;+5) | 12,05 |
| -4 | 1,06 | 0,16 | (-10;+10) | 23,5 |
| -5 | 1,72 | 0,26 | (-250;+10) | 24,75 |
| -6 | 1,61 | 0,24 | (-250;0) | 13,34 |
| -7 | 0,66 | 0,1 | (-250;-11) | 1,25 |
| -8 | 1,14 | 0,17 | | |
| -9 | 1,69 | 0,25 | | |
| -10 | 0,67 | 0,1 | | |

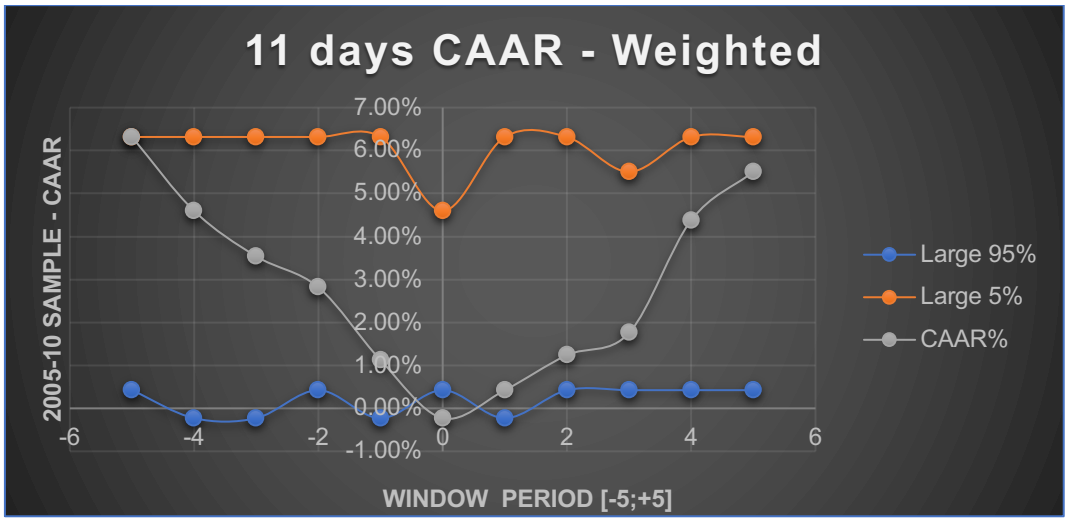

*Figure A-2: 11 days CAAR: 2005-10 sample.*

## Appendix 3: 2011 – 2016 Transactions

*Table A-5: TV and weight descriptive statistics of 2011 – 2016 sample group*

| 2011 – 2016 Sample | Mean | Std Error | Median | Std Dev | Sum | Count | Conf Level (95%) |
|---|---|---|---|---|---|---|---|
| T Value | 5,58 | 1,69 | 6,2 | 4,46 | 39,08 | 7 | 4,13 |
| Weight | 37,34 | 11,01 | 26 | 29,14 | 261,4 | 7 | 26,95 |

*Table A-6: AAR and CAAR for 2011 - 2016 sample portfolio*

| | 2011 - 2016 Sample | | | |
|---|---|---|---|---|
| Period (days) | AAR% | t-stats of AAR% | Window Period | CAAR% |
| 10 | 0,01 | 0,63 | | |
| 9 | -0,0004 | -0,02 | | |
| 8 | 0,01 | 0,49 | | |
| 7 | -0,01 | -0,78 | | |
| 6 | 0,0024 | 0,13 | | |
| 5 | 0,01 | 0,27 | | |
| 4 | 0,0019 | 0,1 | | |
| 3 | 0,01 | 0,58 | (0;+10) | -0,01 |
| 2 | -0,02 | -0,86 | (0;+5) | -0,02 |
| 1 | 0,003 | 0,15 | (0;+2) | -0,03 |
| 0 | -0,02 | -1,12 | (0;0) | -0,02 |
| -1 | -0,0026 | -0,14 | (-2;0) | -0,05 |
| -2 | -0,03 | -1,43 | (-5;0) | -0,06 |
| -3 | 0,02 | 0,91 | (-5;+5) | -0,06 |
| -4 | -0,03 | -1,61 | (-10;+10) | -0,06 |
| -5 | 0,0046 | 0,24 | (-250;+10) | -0,06 |
| -6 | 0,01 | 0,29 | (-250;0) | -0,07 |
| -7 | -0,01 | -0,35 | (-250;-11) | 0 |
| -8 | -0,01 | -0,39 | | |
| -9 | 0,0038 | 0,2 | | |
| -10 | -0,01 | -0,51 | | |

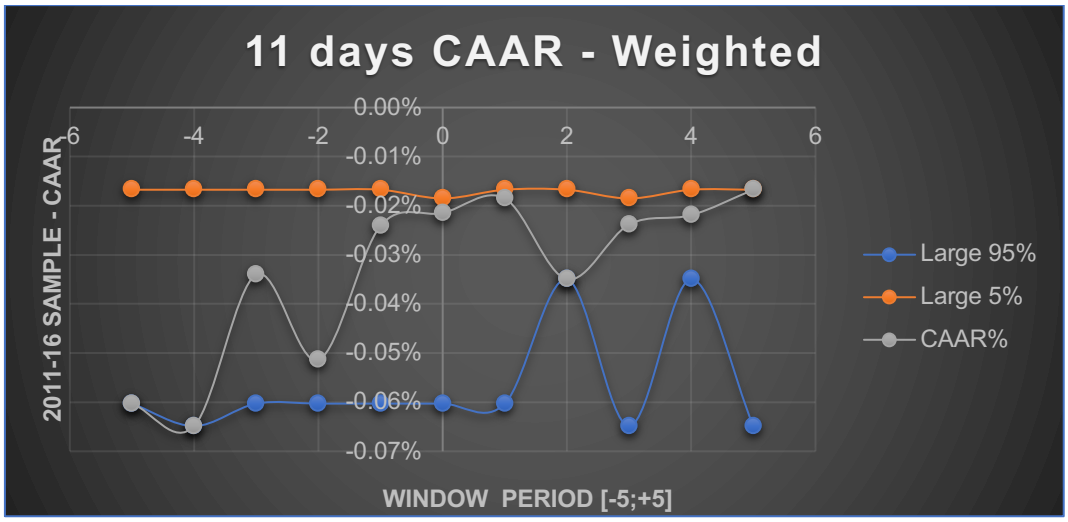


*Figure A-3: 11 days CAAR: 2011-16 sample.*

## Appendix 4: 2017 – 2022 Transactions

*Table A-7: TV and weight descriptive statistics of 2017 – 2022 sample group*

| 2017 – 2022 Sample | Mean | Std Error | Median | Std Dev | Sum | Count | Conf Level (95%) |
|---|---|---|---|---|---|---|---|
| | 2274,5 | 2008,2 | | 5680,2 | 18196,5 | | 4748,8 |
| T Value | 7 | 8 | 185,79 | 6 | 9 | 8 | 2 |
| Weight | 41,75 | 10,2 | 36,38 | 28,84 | 333,98 | 8 | 24,11 |

*Table A-8: AAR and CAAR for 2017 - 2022 sample portfolio*

| | 2017 - 2022 Sample | | | |
|---|---|---|---|---|
| Period (days) | AAR% | t-stats of AAR% | Window Period | CAAR% |
| 10 | 0,36 | 0,11 | | |
| 9 | 0,46 | 0,14 | | |
| 8 | 0,39 | 0,11 | | |
| 7 | 0,18 | 0,05 | | |
| 6 | 0,29 | 0,09 | | |
| 5 | 0,44 | 0,13 | | |
| 4 | 0,11 | 0,03 | | |
| 3 | 0,45 | 0,14 | (0;+10) | 3,95 |
| 2 | 0,59 | 0,18 | (0;+5) | 2,28 |
| 1 | 0,34 | 0,1 | (0;+2) | 1,28 |
| 0 | 0,35 | 0,1 | (0;0) | 0,35 |
| -1 | 0,2 | 0,06 | (-2;0) | 1,16 |
| -2 | 0,62 | 0,18 | (-5;0) | 2,62 |
| -3 | 0,64 | 0,19 | (-5;+5) | 4,54 |
| -4 | 0,3 | 0,09 | (-10;+10) | 7,68 |
| -5 | 0,51 | 0,15 | (-250;+10) | 8,02 |
| -6 | 0,3 | 0,09 | (-250;0) | 4,42 |
| -7 | 0,29 | 0,09 | (-250;-11) | 0,35 |
| -8 | 0,31 | 0,09 | | |
| -9 | 0,22 | 0,07 | | |
| -10 | 0,33 | 0,1 | | |

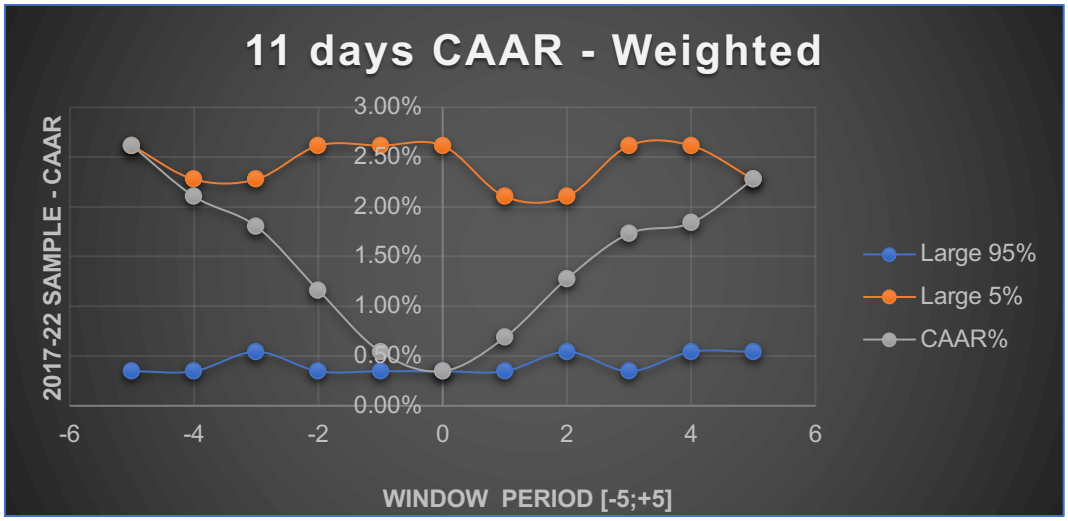


*Figure A-4: 11 days CAAR: 2017-22 sample.*

# Appendix 5: Transaction data (Not all transactions shown)

| Target Name | Transaction ID | Announcement Date | Transaction Type | Deal Status | Transaction Value | Buyer | Sellers | Geography | Transaction Industry | Deal Steak | 250+ Share price data - M&A date | Buyer Stock Exchange | Seller Stock Exchange | Market Cap (-9M) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | |
| Tharisa Minerals (Pty) Ltd. | SPTRD1940767 | 2022/02/16 | M&A - Minority | Completed | 304,81 | Tharisa plc (JSE:THA) | Thari Resources Proprietary Ltd | Africa | Diversified Metals and Mining | 20,00% | Yes | JSE:THA | NA | 548,86 |
| Bauba Resources Limited | SPTRD1938057 | 2022/01/31 | M&A - Minority | Completed | 435,19 | Raubex Group Limited (JSE:RBX) | Absaloms Limited; Tomarnic Limited | Africa | Precious Metals and Minerals | 24,70% | Yes | JSE:RBX | JSE:BAU | 350,22 |
| Royal Bafokeng Platinum Limi | SPTRD1923263 | 2021/12/07 | M&A - Minority | Completed | 1 037,71 | Northam Platinum Holdings Limited (JSE:NPH) | Royal Bafokeng Platinum Limited (JSE:RBP) | Africa | Precious Metals and Minerals | 2,19% | Yes | JSE:NPH | JSE:RBP | 5572,56 |
| Royal Bafokeng Platinum Limi | SPTRD1917320 | 2021/11/09 | M&A - Minority | Completed | 16 305,88 | Northam Platinum Holdings Limited (JSE:NPH) | Royal Bafokeng Holdings Proprietary Limited | Africa | Precious Metals and Minerals | 32,76% | Yes | JSE:NPH | | 4747,78 |
| Bibemi and Wapouzé projects | SPTRD1823548 | 2021/03/31 | M&A - Asset | Completed | 1,56 | Oriole Resources PLC (AIM:ORR) | Bureau d'Etudes et d'Investigations Géologico-minières | Africa | Gold | 51,00% | Yes | AIM:ORR | NA | 3,31 |
| Deep Blue Minerals Pty Ltd | SPTRD1745229 | 2020/06/04 | M&A - Whole | Completed | 0,66 | Kazera Global plc (AIM:KZG) | | Africa | Precious Metals and Minerals | 90,00% | Yes | AIM:KZG | NA | 2,16 |
| 40% in Diro Iron Ore (Pty) Ltd | SPTRD752305 | 2017/08/15 | M&A - Asset | Completed | 44,00 | Afrimat Limited (JSE:AFT) | | Africa | Steel | 40,00% | Yes | JSE:AFT | NA | 273,7 |
| Prieska copper mine & Maryd | SPTRD218793 | 2017/01/03 | M&A - Asset | Completed | 66,77 | Orion Minerals Limited (ASX:ORN) | | Africa | Diversified Metals and Mining | 73,33% | Yes | ASX:ORN | NA | 3,22 |
| Galaxy Gold Mining Ltd. | SPTRD201855 | 2015/04/29 | M&A - Whole | Completed | 11,01 | Galane Gold Ltd. (TSXV:GG) | Galaxy Gold Mining (Pty) Ltd | Africa | Gold | 78,00% | Yes | TSXV:GG | NA | 11,7 |
| Pollux Investment Holdings P | SPTRD208301 | 2014/11/18 | M&A - Minority | Completed | 6,20 | Jubilee Metals Group PLC (AIM:JLP) | Emerald Panther Investments 48 Proprietary Limited | Africa | Precious Metals and Minerals | 7,50% | Yes | AIM:JLP | NA | 15,86 |
| Jubilee Tailings and Treatmen | SPTRD323137 | 2014/11/03 | M&A - Minority | Completed | 0,61 | Jubilee Metals Group PLC (AIM:JLP) | Lipsoset Proprietary Limited | Africa | Precious Metals and Minerals | 25,00% | Yes | AIM:JLP | NA | 11,56 |
| Ergo Mining Operations (Prop | SPTRD193248 | 2014/03/18 | M&A - Minority | Completed | 8,61 | DRDGOLD Limited (NYSE:DRD) | Khumo Gold SPV (Proprietary) Limited; DRDSA Empowerment Trust | Africa | Gold | 26,00% | Yes | NYSE:DRD | NA | 232,44 |
| Jubilee Tailings and Treatmen | SPTRD478870 | 2013/01/25 | M&A - Minority | Completed | 1,46 | Jubilee Metals Group PLC (AIM:JLP) | Jubilee Tailings and Treatment Company Proprietary Limited | Africa | Precious Metals and Minerals | 5,00% | Yes | AIM:JLP | NA | 59,31 |
| Northam Chrome Producers P | SPTRD476582 | 2012/07/01 | M&A - Whole | Completed | 10,00 | Northam Platinum Holdings Limited (JSE:NPH) | Northam Chrome Producers Proprietary Limited | Africa | Diversified Metals and Mining | 70,00% | Yes | JSE:NPH | NA | 1568,23 |
| Mnombo Wethu Consultants ( | SPTRD512556 | 2011/11/09 | M&A - Minority | Completed | 1,20 | Platinum Group Metals Ltd. (TSX:PTM) | Mnombo Wethu Consultants CC | Africa | Precious Metals and Minerals | 49,90% | Yes | TSX:PTM | NA | 431,92 |
| Brownfield Smelting Site with | SPTRD632397 | 2010/05/04 | M&A - Asset | Completed | 10,00 | Jubilee Metals Group PLC (AIM:JLP) | | Africa | Diversified Metals and Mining | 70,00% | Yes | AIM:JLP | NA | 77,28 |
| Jubilee Smelting and Refining | SPTRD632509 | 2010/05/04 | M&A - Whole | Completed | 10,00 | Jubilee Metals Group PLC (AIM:JLP) | Jubilee Smelting and Refining (Pty) Ltd. | Africa | Steel | 70,00% | Yes | AIM:JLP | NA | 77,28 |
| Doornkop South Project | SPTRD631996 | 2010/03/19 | M&A - Asset | Completed | 399,15 | Harmony Gold Mining Company Limited (JSE:HAR) | Africa Vanguard Capital | Africa | Gold | 26,00% | Yes | JSE:HAR | NA | 4500,1 |
| Raptor Minerals (Pty) Ltd. | SPTRD648934 | 2009/12/03 | M&A - Whole | Completed | 0,53 | Kairos Minerals Limited (ASX:KAI) | Raptor Minerals (Pty) Ltd. | Africa | Gold | 90,00% | Yes | ASX:KAI | NA | 2,32 |
| Cullinan | SPTRD174328 | 2009/11/18 | M&A - Asset | Completed | 117,28 | Petra Diamonds Limited (LSE:PDL) | Al Rajhi Holdings W.L.L. | Africa | Precious Metals and Minerals | 37,00% | Yes | LSE:PDL | NA | 90,49 |
| Vergenoeg Mining Company ( | SPTRD562826 | 2009/09/23 | M&A - Whole | Completed | 60,00 | Minerales y Productos Derivados, S.A. (BDM:MYD) | Metorex (Proprietary) Limited | Africa | Diversified Metals and Mining | 55,00% | Yes | BDM:MYD | JSE:MTX | 16,41 |
| Pandora Joint Venture | SPTRD1000211 | 2009/06/30 | M&A - Asset | Completed | 65,00 | Northam Platinum Holdings Limited (JSE:NPH) | Mvelaphanda Resources Proprietary Limited | Africa | Precious Metals and Minerals | 7,50% | Yes | JSE:NPH | JSE:MVL | 1132,8 |
| Tshipi é Ntle Manganese Mini | SPTRD970481 | 2009/06/04 | M&A - Asset | Completed | 34,30 | POSCO Holdings Inc. (KOSE:A005490) | Gemfields Group Limited (JSE:GML) | Africa | Diversified Metals and Mining | 11,36% | Yes | KOSE:A00549 | JSE:GML | 30950,54 |
| Sibanye Stillwater Limited | SPTRD390335 | 2009/03/17 | M&A - Minority | Completed | 6 140,00 | Gold Fields Limited (JSE:GFI) | Mvelaphanda Gold (Proprietary) Limited | Africa | Precious Metals and Minerals | 15,00% | Yes | JSE:GFI | NA | 7148,69 |
| JCI Limited | SPTRD428899 | 2009/01/22 | M&A - Minority | Completed | 11,90 | Investec Group (JSE:INL) | Goliath Gold Mining Limited | Africa | Precious Metals and Minerals | 4,72% | Yes | JSE:INL | JSE:GGM | 4343,53 |
| ATC (Pty) Limited | SPTRD655692 | 2008/09/30 | M&A - Minority | Completed | 117,00 | Reunert Limited (JSE:RLO) | Powerhouse Utilities (Pty) Limited | Africa | Diversified Metals and Mining | 15,00% | Yes | JSE:RLO | NA | 1 812,08 |
| Western Bushveld Joint Ventu | SPTRD656661 | 2008/09/02 | M&A - Asset | Completed | 785,50 | Platinum Group Metals Ltd. (TSX:PTM) | Africa Wide Mineral Prospecting and Exploration (Proprietary) Limited | Africa | Precious Metals and Minerals | 37,00% | Yes | TSX:PTM | NA | 209,63 |
| Assore Limited | SPTRD727353 | 2007/07/16 | M&A - Minority | Completed | 30,09 | Sumitomo Corporation (TSE:8053) | Assore Limited | Africa | Diversified Metals and Mining | 3,14% | Yes | TSE:8053 | JSE:ASR | 15149,06 |
| Barplats Investments Limited | SPTRD406379 | 2007/03/06 | M&A - Minority | Completed | 209,63 | Eastern Platinum Limited (TSX:ELR) | Barplats Investments Limited | Africa | Precious Metals and Minerals | 26,00% | Yes | TSX:ELR | JSE:BPL | 121,52 |
| Barplats Investments Limited | SPTRD418727 | 2007/03/01 | M&A - Minority | Completed | 246,55 | Eastern Platinum Limited (TSX:ELR) | Barplats Investments Limited | Africa | Precious Metals and Minerals | 5,00% | Yes | TSX:ELR | JSE:BPL | 131,17 |
| Assore Limited | SPTRD740660 | 2007/01/11 | M&A - Minority | Completed | 499,98 | Sumitomo Corporation (TSE:8053) | Old Mutual Life Assurance Company (South Africa) Limited | Africa | Diversified Metals and Mining | 10,45% | Yes | TSE:8053 | JSE:ASR | 17362,11 |
| Afriminerals Holdings (Pty) Lt | SPTRD394395 | 2006/08/22 | M&A - Minority | Completed | 8,81 | Eastern Platinum Limited (TSX:ELR) | Afriminerals Holdings (Pty) Ltd. | Africa | Gold | 49,00% | Yes | TSX:ELR | NA | 82,44 |
| Village Main Reef Gold Mining | SPTRD718337 | 2006/06/20 | M&A - Minority | Completed | 0,46 | Harmony Gold Mining Company Limited (JSE:HAR) | African Rainbow Minerals Limited (JSE:ARI) | Africa | Gold | 37,80% | Yes | JSE:HAR | JSE:ARI | 4200,69 |
| Western Areas Limited | SPTRD413964 | 2006/03/09 | M&A - Minority | Completed | 1 534,79 | Harmony Gold Mining Company Limited (JSE:HAR) | Gold Fields Operations Limited | Africa | Gold | 24,25% | Yes | JSE:HAR | JSE:WAR | 2884,59 |
| Columbus Stainless (Pty) Ltd. | SPTRD404548 | 2005/05/13 | M&A - Minority | Completed | 60,81 | Acerinox, S.A. (BME:ACX) | EVRAZ Highveld Steel and Vanadium Limited | Africa | Steel | 12,00% | Yes | BME:ACX | NA | 349,84 |
| Wonderkop Chrome Operatio | SPTRD642805 | 2005/05/04 | M&A - Asset | Completed | 38,77 | Merafe Resources Limited (JSE:MRF) | Samancor Chrome Limited | Africa | Diversified Metals and Mining | 50,00% | Yes | JSE:MRF | JSE:SAMANC | 140,37 |
| Murray & Roberts Cementatio | SPTRD390795 | 2004/07/22 | M&A - Minority | Completed | 5,03 | Murray & Roberts Holdings Limited (JSE:MUR) | Murray & Roberts Cementation Co. Ltd. | Africa | Diversified Metals and Mining | 20,87% | Yes | JSE:MUR | JSE:CMT | 589,41 |
| Avgold Ltd. | SPTRD395144 | 2004/04/15 | M&A - Minority | Completed | 332,98 | Harmony Gold Mining Company Limited (JSE:HAR) | Avgold Ltd. | Africa | Gold | 46,30% | Yes | JSE:HAR | JSE:AVG | 2176,67 |
| Free State Development and I | SPTRD447953 | 2003/08/21 | M&A - Whole | Completed | 1,84 | Randgold & Exploration Company Limited (JSE:RNG) | Free State Development and Investment Corporation Limited | Africa | Diversified Metals and Mining | 55,10% | Yes | JSE:RNG | PSGM:FSDIY | 75,88 |
| SA Mineral Resources Corp, Lt | SPTRD817672 | 2002/08/15 | M&A - Minority | Completed | 1,85 | MC Mining Limited (ASX:MCM) | Cambrian Mining Limited; Deepgreen Minerals Corp Ltd (Walter Energy) | Africa | Diversified Metals and Mining | 34,50% | Yes | ASX:MCM | JSE:MNMN | 1,93 |
| Anglovaal Mining Limited | SPTRD415127 | 2002/03/12 | M&A - Minority | Completed | 1 600,14 | Anglo American plc (LSE:AAL) | African Rainbow Minerals Limited (JSE:ARI) | Africa | Diversified Metals and Mining | 34,90% | Yes | LSE:AAL | JSE:ARI | 25025,16 |
| Columbus Stainless (Pty) Ltd. | SPTRD404558 | 2001/07/25 | M&A - Whole | Completed | 230,55 | Acerinox, S.A. (BME:ACX) | The Industrial Development Corporation of South Africa Limited; EVRAZ Highveld Steel and Vanadium Limited; Samancor Chrome Limited | Africa | Steel | 64,00% | Yes | BME:ACX | N | 1505,24 |

## Appendix 6: Large 5% and Large 95%

| 11 Days (-5:5) | Large5% | Large95% | | CAAR% | 1 CAAR% | 2 CAAR% | 3 CAAR% | 4 CAAR% | 5 CAAR% | 6 CAAR% | 7 CAAR% | 8 CAAR% | 9 CAAR% | 10 CAAR% | 11 CAAR% | 12 CAAR% | 13 CAAR% | 14 CAAR% | 15 CAAR% | 16 CAAR% | 17 CAAR% | 18 CAAR% | 19 CAAR% | 20 CAAR% |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 | 50,35 | 0,00 | | 50,34811 | 13,34771 | 1,259722 | 8,135373 | 14,70439 | 34,69893 | 0 | 13,34771 | 50,34811 | 8,135373 | 0 | 23,43116 | 6,203047 | 3,224454 | 34,69893 | 14,70439 | 1,259722 | 22,03235 | 6,203047 | 50,34811 | 6,203047 |
| 4 | 34,70 | 0,00 | | 34,69893 | 23,43116 | 0 | 13,34771 | 1,259722 | 34,69893 | 23,43116 | 23,43116 | 14,70439 | 1,259722 | 0 | 34,69893 | 23,43116 | 8,135373 | 34,69893 | 23,43116 | 8,135373 | 3,224454 | 34,69893 | 3,224454 | 1,259722 |
| 3 | 34,70 | 3,22 | | 22,03235 | 6,203047 | 3,224454 | 23,43116 | 34,69893 | 8,135373 | 1,259722 | 8,135373 | 23,43116 | 34,69893 | 3,224454 | 6,203047 | 3,224454 | 22,03235 | 22,03235 | 14,70439 | 8,135373 | 22,03235 | 6,203047 | 6,203047 | 22,03235 |
| 2 | 50,35 | 0,00 | | 13,34771 | 3,224454 | 3,224454 | 0 | 0 | 8,135373 | 6,203047 | 22,03235 | 6,203047 | 3,224454 | 0 | 50,34811 | 6,203047 | 23,43116 | 1,259722 | 3,224454 | 8,135373 | 8,135373 | 22,03235 | 50,34811 | 3,224454 |
| 1 | 34,70 | 0,00 | | 6,203047 | 34,69893 | 3,224454 | 8,135373 | 8,135373 | 6,203047 | 8,135373 | 0 | 34,69893 | 22,03235 | 13,34771 | 22,03235 | 8,135373 | 6,203047 | 0 | 13,34771 | 23,43116 | 8,135373 | 0 | 14,70439 | 8,135373 |
| 0 | 50,35 | 0,00 | | 1,259722 | 1,259722 | 23,43116 | 22,03235 | 34,69893 | 1,259722 | 50,34811 | 1,259722 | 22,03235 | 3,224454 | 13,34771 | 23,43116 | 50,34811 | 1,259722 | 13,34771 | 22,03235 | 0 | 0 | 0 | 23,43116 | 3,224454 |
| -1 | 50,35 | 0,00 | | 0 | 6,203047 | 3,224454 | 3,224454 | 23,43116 | 23,43116 | 3,224454 | 13,34771 | 50,34811 | 3,224454 | 0 | 3,224454 | 50,34811 | 3,224454 | 3,224454 | 6,203047 | 14,70439 | 0 | 0 | 6,203047 | 1,259722 |
| -2 | 50,35 | 1,26 | | 3,224454 | 23,43116 | 0 | 14,70439 | 6,203047 | 3,224454 | 13,34771 | 22,03235 | 8,135373 | 50,34811 | 34,69893 | 3,224454 | 1,259722 | 13,34771 | 50,34811 | 8,135373 | 23,43116 | 1,259722 | 8,135373 | 50,34811 | 14,70439 |
| -3 | 34,70 | 0,00 | | 8,135373 | 0 | 13,34771 | 0 | 50,34811 | 14,70439 | 13,34771 | 34,69893 | 34,69893 | 22,03235 | 6,203047 | 23,43116 | 1,259722 | 1,259722 | 14,70439 | 34,69893 | 1,259722 | 1,259722 | 3,224454 | 6,203047 | 8,135373 |
| -4 | 50,35 | 3,22 | | 14,70439 | 23,43116 | 13,34771 | 23,43116 | 23,43116 | 14,70439 | 50,34811 | 1,259722 | 14,70439 | 34,69893 | 8,135373 | 3,224454 | 22,03235 | 34,69893 | 13,34771 | 34,69893 | 23,43116 | 22,03235 | 34,69893 | 13,34771 | 50,34811 |
| -5 | 50,35 | 1,26 | | 23,43116 | 34,69893 | 23,43116 | 34,69893 | 23,43116 | 50,34811 | 1,259722 | 3,224454 | 8,135373 | 8,135373 | 13,34771 | 50,34811 | 14,70439 | 13,34771 | 23,43116 | 13,34771 | 50,34811 | 34,69893 | 1,259722 | 34,69893 | 3,224454 |

## Appendix 7: Correlation Matrix

| | 2022/02/16 | 2022/01/31 | 2021/12/07 | 2021/11/09 | 2021/03/31 | 2020/06/04 | 2017/08/15 | 2017/01/03 | 2015/04/29 | 2014/11/18 | 2014/11/03 | 2014/03/18 | 2013/01/25 | 2012/07/01 | 2011/11/09 | 2010/05/04 | 2010/03/19 | 2009/12/03 | 2009/11/18 | 2009/06/30 | 2009/06/04 | 2008/03/17 | 2009/01/22 | 2008/09/30 | 2008/09/02 | 2007/07/16 | 2007/03/06 | 2007/03/01 | 2007/01/11 | 2006/08/22 | 2006/06/20 | 2006/03/09 | 2005/05/13 | 2005/05/04 | 2004/07/22 | 2004/04/15 | 2003/08/21 | 2002/08/15 | 2002/03/12 | 2001/07/25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2022/02/16 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2022/01/31 | -0,00453386 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2021/12/07 | 0,07650667 | 0,02210745 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2021/11/09 | 0,04269503 | 0,06464201 | -0,00187648 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2021/03/31 | -0,03034229 | 0,00334126 | -0,18186076 | 0,09437287 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2020/06/04 | -0,05519647 | -0,00247924 | 0,00430549 | 0,00077603 | -0,01912596 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2017/08/15 | 0,05129817 | -0,05955279 | 0,01142089 | -0,06219371 | -0,06262594 | -0,05662893 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2017/01/03 | 0,07822386 | -0,04056804 | -0,03517021 | 0,03137726 | -0,05693437 | -0,00031909 | 0,02318883 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2015/04/29 | -0,01491812 | 0,0267477 | 0,07943655 | -0,00373724 | -0,01529509 | -0,00211045 | -0,00136405 | 0,13573719 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2014/11/18 | 0,02179134 | 0,01737369 | 0,07013183 | 0,06525381 | 0,03019838 | -0,03582548 | 0,06571658 | 0,02545198 | -0,10159787 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2014/11/03 | -0,08567024 | 0,09853273 | 0,06062521 | 0,03931953 | 0,04300396 | -0,01045293 | 0,10696147 | -0,06682978 | 0,00010851 | 0,07933218 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2014/03/18 | 0,09425848 | -0,00299475 | 0,07112682 | -0,02724549 | -0,06872122 | -0,01634256 | 0,03390417 | 0,07025595 | 0,03061529 | 0,11782132 | 0,00093188 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2013/01/25 | -0,07910299 | -0,03772751 | -0,05962478 | 0,06888724 | 0,01976091 | 0,00713022 | -0,04326542 | -0,09926884 | 0,09356786 | 0,02469653 | 0,11296139 | 0,07167642 | 1 | | | | | | | | | | | | | | | | | | | | | | | | |
| 2012/07/01 | -0,03449763 | 0,10902589 | 0,05589698 | 0,07284744 | -0,04508576 | -0,02821606 | 0,03141844 | -0,10618835 | -0,02778606 | -0,04100853 | -0,09911452 | -0,03586282 | 0,11903275 | 1 | | | | | | | | | | | | | | | | | | | | | | | |
| 2011/11/09 | -0,03784266 | 0,01988515 | 0,08501028 | 0,01894571 | -0,08747509 | -0,01013260 | 0,09254415 | 0,05612001 | 0,02861972 | 0,00813747 | 0,01388209 | 0,11347269 | -0,01725198 | 0,02569551 | 1 | | | | | | | | | | | | | | | | | | | | | | |
| 2010/05/04 | 0,04907422 | 0,01246048 | -0,00630483 | -0,24775102 | 0,06366267 | -0,02278313 | 0,03958387 | 0,02396652 | -0,01558483 | -0,02937944 | 0,08378687 | 0,03680466 | -0,09227878 | -0,00589767 | -0,03397158 | 1 | | | | | | | | | | | | | | | | | | | | | |
| 2010/05/04 | 0,04907422 | 0,01246048 | -0,00630483 | -0,24775102 | 0,06366267 | -0,02278313 | 0,03958387 | 0,02396652 | -0,01558483 | -0,02937944 | 0,08378687 | 0,03680466 | -0,09227878 | -0,00589767 | -0,03397158 | 1 | 1 | | | | | | | | | | | | | | | | | | | | |
| 2010/03/19 | 0,02523136 | 0,16251218 | 0,01350325 | -0,03414785 | -0,01809306 | 0,04132415 | 0,04790383 | 0,08605169 | -0,01580438 | 0,01692205 | -0,07115844 | -0,09188624 | 0,04543422 | -0,07233834 | 0,02972846 | 0,11328452 | 1 | | | | | | | | | | | | | | | | | | | | |
| 2009/12/03 | -0,10675674 | -0,00054771 | -0,08257282 | 0,05191666 | 0,07345648 | 0,00108943 | -0,05932611 | 0,04773284 | 0,04061959 | 0,02642561 | -0,02218883 | 0,07531523 | -0,10109620 | 0,01199453 | 0,03146411 | -0,02535003 | -0,02535003 | 0,09164542 | 1 | | | | | | | | | | | | | | | | | | |
| 2009/11/18 | 0,01828475 | 0,00123496 | -0,01882892 | 0,00680749 | -0,04155284 | 0,00362806 | 0,02045568 | 0,02459396 | -0,03495429 | -0,00729859 | -0,02809668 | 0,01975583 | -0,01963663 | 0,03142344 | 0,03781656 | -0,00487268 | -0,00487268 | 0,01362887 | -0,11790968 | 1 | | | | | | | | | | | | | | | | | |
| 2009/06/30 | 0,09718476 | 0,06272984 | 0,05397763 | 0,06545394 | -0,01320631 | 0,16816175 | -0,04710337 | 0,05075112 | -0,04714471 | -0,12730219 | 0,02987206 | -0,09687612 | -0,00332727 | -0,10910574 | -0,07508728 | -0,03158072 | -0,03158072 | 0,02765269 | 0,03694746 | -0,01072042 | 1 | | | | | | | | | | | | | | | | |
| 2009/06/04 | -0,12885011 | 0,0267349 | -0,09308237 | -0,02896236 | 0,01577733 | 0,00382528 | 0,01107969 | -0,06598981 | 0,0096614 | -0,10967242 | -0,03422761 | -0,00456148 | 0,10256273 | 0,01103048 | 0,02332986 | 0,05949992 | 0,05949992 | 0,06967899 | -0,10326923 | 0,04150546 | -0,10528182 | 1 | | | | | | | | | | | | | | |
| 2009/03/17 | 0,05223426 | -0,00972423 | 0,08541592 | 0,02264501 | -0,03742342 | -0,0074522 | -0,00434282 | 0,16772689 | -0,03978032 | 0,01637404 | 0,04091473 | 0,02167488 | -0,02883297 | -0,04627004 | -0,00421959 | -0,00421959 | 0,0233454 | 0,00744192 | 0,07011746 | -0,02733816 | 0,05536328 | 1 | | | | | | | | | | | | | | |
| 2009/01/22 | -0,02747126 | -0,01648304 | 0,02598623 | -0,02764134 | 0,04027563 | 0,05903178 | -0,02548286 | 0,06869498 | 0,04425423 | -0,00767267 | 0,01892645 | 0,05136043 | 0,02402121 | 0,02617229 | 0,02052858 | 0,00671651 | 0,00671651 | -0,00489907 | 0,04378394 | 0,08273832 | 0,00706341 | 0,09105428 | 0,02652191 | 1 | | | | | | | | | | | | |
| 2008/09/30 | -0,02844839 | -0,02843769 | 0,14340638 | -0,01503942 | -0,08297979 | -0,03208163 | 0,04850998 | 0,03382976 | -0,00399154 | -0,02557644 | 0,05996795 | 0,07448844 | 0,02921305 | -0,02302686 | 0,07018692 | -0,05137754 | -0,05137754 | -0,00629584 | -0,04688226 | 0,15703274 | 0,00410307 | -0,0849443 | -0,07038115 | -0,02349628 | 1 | | | | | | | | | | | |
| 2008/09/02 | 0,02217858 | -0,01000126 | 0,00766753 | -0,05310765 | -0,03661253 | 0,01667493 | 0,00752214 | 0,00765905 | 0,05722345 | 0,12036954 | -0,0102765 | -0,01915495 | -0,05507493 | -0,07576101 | -0,07639104 | -0,05501477 | -0,08324879 | 0,07145027 | 0,04194992 | 0,03597674 | -0,05889438 | -0,00617959 | 0,02089093 | 0,00353762 | 1 | | | | | | | | | | | |
| 2007/07/16 | -0,06992585 | -0,06024513 | -0,03941003 | -0,09090418 | -0,09444436 | 0,01045061 | -0,00239023 | -0,01554406 | 0,12071889 | 0,18937614 | 0,00263413 | 0,10358525 | 0,09144108 | -0,07963942 | 0,08077286 | 0,04225739 | 0,02843768 | 0,08588655 | 0,07463698 | -0,0898832 | 0,04552403 | 0,00752458 | 0,06347624 | 0,07465306 | 0,00163207 | 1 | | | | | | | | | | |
| 2007/03/06 | -0,07075421 | 0,00180761 | 0,01870195 | 0,08280139 | 0,08534242 | 0,00948548 | 0,00959918 | -0,04801682 | -0,02131539 | 0,08199815 | -0,01851833 | -0,02513516 | -0,11085217 | 0,09599406 | 0,05382774 | -0,02387517 | -0,02387517 | -0,00362551 | 0,05296855 | -0,05228735 | -0,01784173 | 0,00917439 | 0,01459744 | -0,03436509 | 0,00179794 | -0,03628652 | 0,059065693 | 1 | | | | | | | | |
| 2007/03/01 | -0,02745446 | 0,02203672 | -0,10510405 | 0,01841121 | 0,00482852 | -0,02580264 | 0,00568599 | 0,06378038 | 0,03047124 | 0,04318657 | -0,11052021 | 0,02891851 | 0,01018044 | -0,00880171 | -0,00852741 | 0,07036798 | 0,07036798 | -0,14912726 | 0,06306851 | 0,00987826 | 0,07351481 | 0,03899214 | 0,02627584 | -0,04143162 | 0,04388904 | 0,05403515 | -0,01694368 | -0,14960330 | 1 | | | | | | | |
| 2007/01/11 | -0,00878497 | -0,02673218 | -0,00569146 | -0,05693659 | -0,07729584 | -0,00648834 | -0,01429718 | 0,03253834 | 0,02090538 | -0,06978656 | -0,01980181 | -0,00281764 | 0,03827363 | -0,04742804 | 0,03637873 | -0,03744749 | -0,03744749 | 0,03130425 | 0,01147624 | -0,13697907 | -0,03144184 | 0,11721417 | 0,02354132 | 0,04775714 | 0,05409589 | -0,12282946 | 0,092806037 | 0,06475035 | -0,02147699 | 1 | | | | | | |
| 2006/08/22 | -0,05733473 | -0,05790746 | 0,02528827 | -0,07189781 | -0,09195063 | -0,03460775 | -0,01461668 | 0,01310612 | -0,0238868 | -0,02891692 | 0,10871827 | 0,07360794 | 0,04309583 | -0,06229836 | -0,00915668 | 0,05114718 | 0,05114718 | -0,07228693 | -0,01570497 | 0,06305702 | -0,07681992 | -0,09191404 | 0,068234267 | 0,02528457 | 0,11351978 | -0,14368184 | 0,04282725 | -0,02704252 | 0,061321102 | -0,00340041 | 1 | | | | | |
| 2006/06/20 | -0,00174488 | 0,03141582 | -0,08006783 | -0,07112188 | 0,036656202 | 0,11286048 | 0,02335304 | 0,07026079 | 0,09902882 | -0,05409907 | -0,10696857 | -0,04554748 | -0,01420418 | -0,02033852 | -0,05987955 | 0,08759421 | 0,08759421 | -0,07208561 | 0,03912159 | -0,07657076 | 0,04003481 | 0,06509738 | 0,050043612 | 0,040077785 | -0,05362418 | -0,12023429 | -0,00580898 | -0,09076429 | 0,111367473 | -0,01636544 | -0,03280439 | 1 | | | | |
| 2006/03/09 | 0,03192869 | -0,01065795 | -0,03599803 | -0,04217728 | -0,02233924 | 0,00490055 | 0,11309319 | -0,00026521 | -0,02191001 | -0,09716925 | -0,01506493 | -0,11890481 | -0,06493751 | -0,04309518 | 0,05788377 | -0,00937696 | -0,00937696 | -0,08451408 | -0,01016983 | 0,01478106 | -0,04227167 | -0,02884717 | 0,010919326 | -0,03219906 | -0,03027596 | -0,03934234 | 0,055748469 | 0,020001355 | 0,080042743 | 0,015448848 | -0,03314846 | 0,163449316 | 1 | | | | |
| 2005/05/13 | 0,05152218 | 0,03003033 | -0,00118749 | -0,03007033 | -0,00611434 | 0,07179405 | -0,08732146 | 0,038583534 | 0,07459975 | 0,04052957 | 0,05276795 | 0,04133403 | 0,02983743 | -0,03572106 | 0,01093803 | -0,05691861 | -0,05691861 | -0,09105205 | -0,10584156 | 0,06202855 | -0,04125246 | -0,07043288 | -0,06567218 | 0,012187886 | 0,010456857 | -0,01902057 | 0,007507249 | 0,012489667 | -0,0510316 | -0,04678715 | -0,07944926 | -0,02608123 | 0,029769743 | 1 | | | |
| 2005/05/04 | -0,11977205 | -0,08732703 | 0,07693695 | -0,03764943 | -0,00936388 | -0,01044984 | 0,01207624 | -0,04120656 | -0,00255444 | -0,04076212 | -0,06647679 | 0,059506291 | 0,007099509 | -0,14547063 | 0,087566356 | -0,02158174 | -0,02158174 | -0,01085046 | -0,01041932 | -0,01643864 | -0,00871236 | 0,103706676 | 0,005099232 | 0,026782662 | 0,075167433 | -0,03039528 | 0,012300713 | -0,09370485 | 0,078867795 | 0,002779113 | -0,00073628 | 0,082996697 | 0,087925615 | 0,064359775 | 1 | | |
| 2004/07/22 | 0,00022407 | -0,10466484 | -0,06419008 | -0,04911178 | 0,069575065 | 0,027688566 | -0,05157331 | 0,131377639 | 0,038606993 | 0,022602195 | -0,07500633 | 0,043188507 | -0,08734925 | 0,037022229 | 0,017508791 | 0,02894572 | 0,02894572 | -0,03895126 | 0,17743369 | -0,04368289 | 0,104300959 | -0,0448529 | -0,026135837 | 0,034605931 | 0,04133415 | 0,031517084 | 0,049577673 | -0,0016596 | 0,036296228 | -0,03714376 | 0,130406621 | 0,029631073 | 0,021031683 | -0,069651439 | 0,002941276 | 1 | |
| 2004/04/15 | -0,08593062 | -0,06243605 | 0,000599531 | 0,132936731 | 0,084456748 | -0,05926747 | 0,111636803 | 0,002494632 | 0,013809224 | 0,067526078 | 0,011291516 | 0,118734872 | 0,03704483 | 0,03389678 | -0,02386274 | -0,15769333 | -0,15769333 | -0,0274715 | 0,110391647 | -0,01990425 | 0,035295785 | 0,020378697 | -0,054479489 | -0,012952655 | 0,073617166 | 0,05688977 | 0,060029307 | 0,004424738 | 0,046590726 | -0,01870318 | -0,02165621 | 0,010024031 | 0,01618844 | -0,08988418 | 0,00713822 | 0,007790073 | 1 | |
| 2003/08/21 | -0,00766273 | -0,03079909 | -0,09328295 | -0,15445765 | 0,057075219 | -0,04889414 | 0,064891926 | -0,08032871 | -0,05883821 | 0,039793065 | 0,016905944 | 0,038362512 | -0,10819482 | -0,05121498 | -0,03933417 | 0,070833111 | 0,070833111 | 0,101112397 | -0,05095811 | -0,06864786 | -0,01830391 | 0,039542497 | 0,053101415 | -0,056091386 | -0,0568271 | -0,04255308 | 0,018023197 | -0,12912921 | 0,067415094 | 0,073623187 | 0,052064215 | 0,046682024 | 0,06629427 | 0,016198554 | 0,088432015 | 0,054176732 | 0,004975571 | 1 | |
| 2002/08/15 | 0,015094929 | -0,00135908 | -0,00252779 | 0,062437161 | -0,01535409 | -0,00208102 | 0,061620095 | -0,04390526 | 0,167403415 | 0,008841054 | 0,068328285 | 0,079827963 | -0,06505439 | -0,02729 | -0,02473407 | -0,00473853 | -0,00473853 | -0,06799334 | -0,06911537 | 0,061184771 | 0,027278071 | -0,0921221 | 0,052306411 | -0,028573936 | 0,028276452 | 0,01755634 | 0,028926191 | 0,044030489 | -0,0314536 | 0,073042914 | 0,139252632 | 0,027992583 | 0,004735495 | -0,07652786 | -0,065842463 | 0,046527979 | 0,00319919 | -0,054225103 | 1 | |
| 2002/03/12 | 0,101256113 | -0,01334096 | 0,096283336 | 0,014529224 | -0,00870932 | -0,01546578 | -0,03769949 | -0,03917336 | 0,013145514 | -0,01254893 | 0,028758936 | 0,071359697 | 0,101261505 | -0,04992566 | 0,084784039 | -0,01925594 | -0,01925594 | -0,05993225 | 0,044305532 | -0,06716637 | -0,08630354 | 0,165331256 | -0,01655744 | 0,017405684 | 0,013899382 | 0,046259574 | 0,004245659 | 0,030464102 | -0,03260842 | 0,04076552 | 0,003035084 | -0,02572892 | -0,01878973 | -0,00814275 | 0,072736145 | -0,00265822 | 0,044284047 | 0,003809944 | -0,02505304 | 1 |
| 2001/07/25 | 0,05297254 | -0,00644551 | -0,02567384 | -0,10437472 | 0,002638525 | -0,00103949 | 0,02771925 | -0,03805946 | 0,060331623 | -0,17779252 | 0,013102709 | 0,06736126 | 0,164806419 | -0,02381852 | 0,002387565 | -0,00429581 | -0,00429581 | -0,12072571 | 0,003199591 | -0,01004299 | -0,00159703 | 0,029127678 | 0,036103684 | 0,028178026 | 0,008723389 | -0,0231255 | -0,14729419 | -0,00521782 | -0,02657117 | 0,088926561 | 0,028745273 | -0,00239147 | -0,00481093 | -0,00083473 | -0,01145191 | -0,01140042 | -0,03463545 | 0,036069471 | -0,02862842 | -0,00573853 | 1 |