Market Valuation of Junior Natural Resources Companies

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This thesis is submitted in total fulfilment of the requirements for the degree of Doctor of Philosophy

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Submitted in June 2015

Abstract

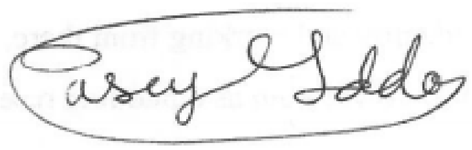
Junior mining companies provide a vital feedstock to the mining sector, which in turn, feeds into the wider economy via manufacturing. The valuation models traditionally used in other sectors of the economy appear to be insufficient, in terms of scope and capacity to handle uncertainty, to provide a rational pricing of junior mining companies. The observation that junior mining firms are valued by some means suggests that either the junior mining markets are inefficient or, more likely, that these markets are able to provide insight, scope, and capacity to the methods of firm valuation.

The process by which natural resource companies are valued on equity markets is poorly understood, especially for those companies at an early stage-of-development focussed upon exploration and the development of embryonic natural resources. Thus, the primary research question motivating this research is: How does the market value junior natural resource companies? While a number of studies have contributed to our understanding of market valuation within the junior natural resources sector, the extant research is often siloed in a focus on traditional value-relevant factors that neglects other factors that potentially have even greater value-relevance. A key contribution of this research is to identify, define and subsume potential value-relevant factors into a conceptual framework of junior mining firm valuation. Another key contribution of this research is its empirical analysis of the relevance of accounting information in 2,324 junior mining companies and an empirical event study into 1,526 seasoned equity offerings by junior mining companies. The findings support the value-relevance of commodity prices and reveal that natural resource companies tend to undertake seasoned equity offerings following persistent market outperformance.

This research, by conjoining the extant literature with empirical analysis in a mixed methods approach, provides an integrated account of market valuation within the junior natural resource sector.

Statement of Authorship

Except where explicit reference is made in the text of the thesis, this thesis contains no material published elsewhere or extracted in whole or in part from a thesis by which I have qualified for or been awarded another degree or diploma. No other person's work has been relied upon or used without due acknowledgement in the main text and bibliography of the thesis.



01/06/2015

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Acknowledgements

This work is greatly indebted to Intierra Pty Ltd (Intierra) for granting permission to employ their proprietary database for the empirical analyses conducted herein. Intierra was considered the leading supplier of business information to the natural resources industry and this research only scratched the surface of their rich database. Subsequently, Intierra merged with Raw Materials Group (RMG) to become IntierraRMG. IntierraRMG was thereafter acquired by SNL Financial who also recently acquired Metals Economics Group and now offer their combined services – focussed upon the mining industry – as SNL Metals & Mining. Acknowledgement also extends to the Securities Industry Research Centre of Asia-Pacific (SIRCA) for providing access to the Thomson Reuters Tick History database.

To my Principal Supervisor, Dr. Samanthala Hettihewa, for setting me on the academic journey and encouraging me every step of the way. Also, Professor Brian West, my Associate Supervisor, for always providing sage guidance and steadfast encouragement. In addition, thanks to Andrew Mortimer, an active participant in the junior mining industry, for his help and belief in the project from its inception. Likewise, Professor Chris Wright, for his mentorship, support and insightfulness.

Finally, my deepest thanks to my family for their support and spirit. Especially my wife, Srilatha, for her loving support as well as practical and creative counsel, without which this work could never have been completed. Also my son, Atash, having just marked his first birthday, for teaching me greater awareness and the power of persistence.

Dedication

This work, completed at Federation University Australia, in Ballarat, and centred upon the natural resources industry, is dedicated to those brave souls who fought and died under the Southern Cross Banner at the Eureka Rebellion. The Eureka Rebellion was a focussed outcry from Ballarat's gold diggers against the corruption and impositions upon individual liberty imposed by the authorities. Through terrible hardship and great personal risk individuals from every corner of the globe journeyed to Ballarat and the surrounding regions and searched for the elusive gold. Through their successes and failures they helped catalyse and create the nation state of Australia.

Research Outcomes Produced in Connection with this Thesis

Journal Articles (ABDC ranked)

Iddon, C., Hettihewa, S., & Wright, C. S. (2013). Junior Mining Sector Capital-raisings: The Effect of Information Asymmetry and Uncertainty Issues. *Journal of Applied Business and Economics*, 15(3), 56–67.

Iddon, C., Wright, C. S., & Hettihewa, S. (2014). Externalizing Intolerable Risk and Uncertainty: The Mining Sector as a Strategic-Cost Leader. *Cost Management*, 28(6), 42–48.

Iddon, C., Wright, C. S., & Hettihewa, S. (2015). Value Relevance of Accounting and Other Variables in the Junior-Mining Sector. *Australasian Accounting Business and Finance Journal*, 9(1), 25-42.

International Conferences

Iddon, C., Hettihewa, S., & Wright, C. S. (2013). Information Asymmetry and Uncertainty Issues in Junior Mining Sector Capital-raisings. *National Business and Economics Society 13th Annual Conference*, 6-9 Mar/13, Marriott Los Suenos, Costa Rica.

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Abbreviations

AMEC	Association of Mining and Exploration Companies
Amex	American Express (not related to AMEX)
ANFO	Ammonium nitrate fuel oil (AMEX(TM); not related to Amex)
ASX	Australian Stock Exchange
BFS	Bankable Feasibility Study
BRIC	Brazil, Russia, India and China
CAR	Cumulative Average Abnormal Return
CI_{NRS}	Natural Resource Sector Commodity Index
DCF	Discounted Cash Flow
GAAP	Generally Accepted Accounting Principles
GDP	Gross Domestic Product
GFC	Global Financial Crisis
IPO	Initial Public Offering
JORC	Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves; produced by the Australasian Joint Ore Reserve Committee (‘the JORC Committee’)
NPV	Net Present Value
NRC	Natural Resource Company

NRS	Natural Resource Sector
PVF	Potentially Value-relevant Factor
R&D	Research and Development
RICI-M	Rogers International Commodity Index®-Metals
SEO	Seasoned Equity Offering
TSX-V	TSX Venture Exchange
USD	US Dollar
VWAP	Value Weighted Average Price

Chapter 1: Introduction

Currently there is no authoritative, widely-accepted methodology to value natural resource companies (NRCs) at an early stage-of-development. Further, as will be shown in this thesis, the quoted share prices of such firms often provides little insight into their future value. While this sector tends to be relatively small in terms of its total market capitalisation, its putative output provides a vital feedstock into the mining sectors of many nations (e.g. Australia, Canada, USA), which (in turn) feed the vital manufacturing, energy, and transportation sectors. Thus, any diminishing of the early stage NRCs is likely to have profound knock-on effects throughout the world economy.

1.1 The Gap in the Literature

The valuation of NRCs on equity markets is widely acknowledged as opaque. This opacity is generally recognised as a product, in large measure, of the preponderance of NRCs at an early stage-of-development (i.e. are generally focussed upon exploration and the advancement of embryonic natural resources). Such a business model clouds foreseeability with regards to the extent and timing of future earnings, rendering NRCs particularly difficult to comprehend from a valuation perspective. In particular, there are profound difficulties involved in valuing exploration acreage and embryonic resources (Lawrence, 2002). In fact, according to (Lonergan, 2006), any attempt to value exploration acreage, an inherent component of virtually all NRCs, should be viewed with "professional scepticism" (p.129) while Rudenno (2010) states:

> "In most cases the valuation, which is undertaken by the 'expert', will be very subjective, depending on the individual's expertise and experience".

Thus, there is a profound absence of any authoritative and widely-accepted methodology by which to value NRCs at an early stage-of-development, without reference to a quoted share price (Lonergan, 2006). The murkiness associated with valuations in the natural resource sector (NRS) even extends to the market pricing of NRCs at advanced stages-of-development. In particular, the valuation of NRCs developing resources to the point of production is beset by, amongst other issues, considerable subjectivity and bias (Lawrence, 2000). Even the valuation of NRCs with operational mines is troublesome, given the innate unpredictability of key inputs to the valuation, like commodity prices and exchange rates (Padley, 2009). For the case of gold-focussed NRCs, the ambiguity afflicting the valuation process is fittingly articulated by Lassonde (1990, as cited by

Lawritsen, 1993, p.13), “for most investors, private as well as institutional, weighing the value of gold shares is seen as a nebulous mix of finance and engineering that’s closer to alchemy than financial analysis.” Thus, even the market values of NRCs at advanced stages-of-development is often characterised as incomprehensible.

The failure to adequately comprehend the mechanisms by which the market values NRCs represents a considerable knowledge vacuum. In particular, the factors of value-relevance in the NRS, and the constellation of circumstances under which they operate, remain steeped in mystery. The conundrum can be stated thus: market price should be the decisive measure of value within the NRS, but the method by which the market arrives at value is ubiquitously enigmatic. This is the gap in the literature that this research seeks to help bridge.

There are a number of possible deficits in the literature that have contributed to the perpetuation of this gap. One identifiable deficit, that this research seeks to alleviate, is the dearth of coherent and systematic accounts of market valuation in the NRS. In particular, the extant literature primarily contributes by in-depth examination of specific areas of value-relevance to the NRS. Such in-depth examinations necessarily preclude comprehensive consideration as to how market value, the product of many discrete areas of value-relevance, is generated. Thus, it is contended that the extant literature is characterised by a haphazard profusion of divergent and narrow foci with little attempt at either unification or a weeding out of measures which are patently unfit for purpose.

Another identifiable deficit, that this research seeks to remedy, concerns the empirical branch of the literature, which often employs samples that, potentially, are not representative of the NRS. Specifically, extant empirical research in the NRS employs samples drawn from one, or at most a few, stock exchanges. Such exchange-centric samples do not reflect the global nature and business environment of the NRS. Moreover, with a few notable exceptions, the sample sizes upon which the extant empirical studies are based are very small.

1.2 Research Question

Given the gap identified in the literature (i.e. the mystery of how the market imputes value in the NRS), the primary research question is:

How does the market impute value to a given NRC?

In answering this question, and in order to avoid overly-heroic assumptions about what is and is not value-relevant and the magnitude and nature of that relevance, the term ‘potentially value-relevant factor’ (PVF) is employed. Accordingly, PVF refers to a factor suggested by the literature as influencing market valuation within the NRS - irrespective of the strength of the theoretical and empirical evidence. The only proviso to this definition of PVFs being, in accordance with the fundamental analysis tradition to which this research is heir, that a PVF must be assessable in systematic fashion – that is, the PVF must be quantifiable. In answering the primary research question, the role of PVFs is therefore deemed vital.

To answer the primary research question, two subsidiary research questions must be addressed under this research. These two subsidiary research questions, both of which centre upon PVFs, are as follows:

(1) What are the PVFs within the NRS suggested by the literature?

(2) How do the PVFs interrelate in context to determine the market value of NRCs?

1.3 Methodology

The research methodology adopted herein may be classified as ‘Mixed Methods Research’, in that it entails the integration of qualitative and quantitative methodologies. In particular, the qualitative thread of this research is borne out by a comprehensive review of the literature to identify PVFs within the NRS. Meanwhile, many PVFs (i.e. value factors identified via the literature review) are subsequently tested via statistical analyses that form the quantitative element of the research. The research concludes by integrating the qualitative and quantitative findings into a conceptual framework which provides insight into how market values are imputed in the NRS. Accordingly, this section seeks to provide more detail regarding the mixed methods approach guiding the research.

Prior to any qualitative and quantitative analysis, the objective of this study is to define the unit of its analysis, namely, the NRC. These units, NRCs, in aggregate and in conjunction with their principals and other stakeholders, make up the NRS. Having defined its subject matter, the body of this work addresses a subsidiary research question:

What are the PVFs within the NRS suggested by the literature?

The reviewed literature includes works of scholarship, industry publications, and pronouncements from NRCs. Also, to better illustrate certain PVFs, actual case-studies are drawn from the received NRS literature and are discussed.

The PVFs so-identified under the literature review are thematically organised and form the subject of Chapters 3 to 11. Two of those Chapters pertain to accounting-based PVFs and capital raising-based PVFs and involve statistical analyses to either confirm or disprove, empirically, the value-relevance of their PVFs in practice. These statistical analyses are based upon large datasets sourced from the proprietary Intierra database.[1] As previously noted, PVFs refer to any factor suggested by the literature as influencing market valuation within the NRS. The only limitation to this definition being that, the PVF must be quantifiable, for instance, a continuous or categorical variable.

Having conducted certain empirical analyses and, moreover, identified PVFs with a bearing on the NRS, the remaining subsidiary question awaits, namely: How do the PVFs interrelate in context to determine the market value of NRCs? To this end, a conceptual framework is developed to integrate the PVFs identified, in terms of their contextual interactions – alternatively theoretically or empirically supported as the case may be - and through which this research contends market valuations coalesce in the NRS. By this mixed methods approach the primary research question, ‘How does the market value NRCs?’ will be addressed.

1.4 Preview of Findings

The principal findings to arise from this research are expressed in the conceptual framework (Chapter 12). This conceptual framework integrates the PVFs drawn from the literature into an integrated account of how market value is imputed in the NRS.

Empirically, this research confirmed the value-relevance of macroeconomic conditions, as manifested by commodity prices. The research also found, in an in-depth examination of PVFs related to seasoned equity offerings (SEOs), that the 90 day period leading up to the announcement of a capital raising is marked by cumulative abnormal returns in the order, on average, of 10 percent. This outperformance was positively related to the size of the SEO relative to the NRC’s market capitalisation, and was negatively

[1] The agreement struck with Intierra, and under which this research was conducted, is included in the Appendix to this work. Indeed, this research represents the first time that permission has been granted to utilise the Intierra data for academic purposes. Intierra is now a part of SNL Metals & Mining.

correlated to liquidity. However, the value-relevance of accounting information could not be affirmed. Given the relative importance of accounting information in valuing firms in other sectors, this last findings was (to say the least) somewhat surprising.

1.5 Contribution to the Literature

The principal gap in the literature, this this research seeks to ameliorate, is the general dearth of systematic and coherent explanations of how market value is imputed in the NRS. While the market value of NRCs is the product of a range of PVFs, most extant research focusses upon specific PVFs. Accordingly, these studies provide valuable insight into the details of specific PVFs, but neglect other PVFs, including those that provide a vital value context. This research builds on these extant studies by providing an integrated account of market valuation within the NRS.

Still, it is important to note that despite the general proclivity in the literature towards in-depth examination of specific PVFs, there are isolated works that do employ a comprehensive perspective in considering market valuation within the NRS. One notable work is the preface of *The Mining Valuation Handbook* by (Rudenno, 2010), which notes:

> "I have often been asked if there is a text that covers the myriad related and interrelated financial issues in the resources industry. There are many good books that cover specific issues, some of which unfortunately are out of print, but none that encompasses all the issues. Therefore, in 1998 I wrote the first edition in an attempt to bring everything into one easy-to-use reference work."

Another notable work with a comprehensive bent is Kennedy's (1996) thesis – an empirical analysis of over 200 NRCs to identify factors that drive performance in the sector. Nevertheless, the work herein provides unique contributions that these other works, albeit also comprehensive in orientation, do not. In particular, Rudenno's (2010) work is not directed, per se, towards an academic audience, and so provides only modest citation of other relevant literature. Moreover, Rudenno's (2010) work provides a different emphasis to this work, for instance, providing only cursory inspection to the issues of speculation and capital raisings; areas to receive methodical consideration herein. Likewise, Kennedy's (1996) thesis, while broad in its scope, emphasises a different pattern of issues, like the importance of company management, as compared to this work. Furthermore, the investigation conducted herein is more representative of the NRS in its entirety, given that Kennedy's sample was isolated to newly listed NRCs on the Australian Stock Exchange (ASX). Thus, the central contribution of this research is achieved by providing a unique, in addition to an integrated, account of how the market formulates value within the NRS.

Aside from providing an integrated account of market valuation within the NRS, this research also involves statistical analyses to verify the value-relevance of the many PVFs suggested by the literature. In particular, panel data analysis is conducted to test the value-relevance of a gamut of accounting-based PVFs while controlling for the macro-economic context; where macroeconomic context is represented through the medium of commodity prices and proxied by a novel commodity-price index. As a result, this research adds to the NRS valuation research, captures the impact of the macro-economy with respect to other company level factors, and mitigates the noted dearth of such research (Richardson, Tuna, & Wysocki, 2010). Moreover, based upon a final sample of 2,324 NRCs, this analysis represents the first use of panel data analysis to investigate market valuation within the NRS. Additionally, an event study is conducted to determine the value-relevance of SEOs to the market valuation of NRCs.

While SEOs play a vital role in ensuring the continuing viability for the bulk of NRCs, there are few studies on SEOs and more studies have focussed upon initial public offerings (IPOs)—e.g. in the NRS, How, 2000; Dimovski & Brooks, 2008; McPherson, 2011), only one study could be located which examined the role of SEOs – namely (Cranstoun, 2010). The sample of SEOs employed under this research represents a considerable step-up in terms of sample size: where Cranstoun's (2010) sample involved 101 SEOs, this research captured a final sample of 1,526 SEOs.

Importantly, the superior samples employed in this research were made possible by engaging the proprietary Intierra database. Intierra is a world leader in collecting and aggregating information pertaining to the resources sector from global equity markets.[2] The unique Intierra datasets employed in this research were available on-line to subscribers and represented a comprehensive database of the global resources sector. As of 2011 when the data employed in this research was collected, the Intierra database captured more than 3,500 listed companies involved in the natural resources industry, 39,000 global projects held by these companies, and 160 commodity-types. The sources for this data are varied but include reports to the financial markets, news feeds, government lease data and technical data (Intierra, 2012). Accordingly, the Intierra database captured, in its virtual entirety, the underlying population of NRCs comprising the NRS. Hence, through use of the Intierra database, this research represents, to the best

[2] Ibid note 1.

of the researcher's awareness, the most comprehensive and rich datasets employed in the literature to date.

Furthermore, use of the Intierra database enabled this research to represent all major nations and stock exchanges of the world where NRCs are active and thus be global in scope. This represents a quantum improvement over previous empirical research in the field, as Ballard and Banks (2003, p.287) laments, "It is surprising, given the transnational nature of the industry, that studies of mining have been persistently parochial and regional in their scope." As a consequence of the Intierra database, the samples employed in this research are not only larger than any previous work in the field, but more comprehensive, in that they capture every major equity market and geographic locale in which NRCs are active.

In summary, the principal contribution of this research is to integrate the available literature to present a unique, coherent and systematic conceptual framework explaining market valuation in the NRS. In support of this conceptual framework, empirical analyses are conducted. Notably, these empirical analyses are an order of magnitude more comprehensive in terms of firm numbers and geographical coverage than prior research. Specifically, the empirical analyses furnishes new insights into the value-relevance of accounting information, commodity prices and capital raisings to the NRS.

1.6 Situating the Research

The purpose of this section is to situate the research in terms of the broader business context and research cross-currents from whence it arises. To this end, this section firstly discusses the commodity price super cycle and consequent flourishing of the NRS: the business context that inspired this research. Moreover, these ebullient market conditions for the NRS persisted during the period over which the research was conducted, so as to provide an essential contextualising backdrop to the research. Additionally, this section identifies an important line of scholarship as a sector-specific study. Further, this section identified sector-specific studies targeting venture capital dominated sectors as especially pertinent. Subsequently, fundamental analysis, the primary research tapestry to which this work is heir, is chronicled. Finally, the theoretical foundations underpinning this work are discussed.

1.6.1 Commodity Price Super Cycle

The importance of the NRS, and by implication NRS-focussed research, has increased markedly since early 2000, commensurate with the industrialisation and urbanisation of the BRIC nations.[3] These BRIC nations, alongside other rapidly developing economies, have precipitated a sustained commodity price super cycle. Generally held to have begun in 2005, the commodity price super cycle has created enhanced opportunities for those NRCs capable of supplying the natural resources necessary to support the rapid industrialisation and urbanisation underway in these rapidly developing economies (Battellino, 2010). This has resulted in burgeoning investment interest in the NRS, resulting in an expansion in both the absolute and relative size of the NRS on global equity markets. Concurrently, there has been a major step-up in the volume of price sensitive news being issued onto global equity markets from the NRS. Consider, for example, the ASX – home to the largest number of NRCs of any exchange - save Canada's TSX Venture Exchange. The dramatic rise in the number of NRCs due to the commodity price super cycle on the ASX is evidenced by the following quote (ASX, 2011):[4]

> "The Metals & Mining sector is the largest industry sector by number of companies with almost 700 companies involved in mineral exploration, development and production...Investors in the Australian market have supported over 400 new junior resource floats in the last 5 years."

Thus, in the context of the Australian market, the number of firms in the NRS has more than doubled in a short span of time, reflecting Australia's status as a major resource-based economy.[5] Meanwhile, the commensurate increase in the news flow from these companies is evidenced by Figure 1. Specifically, Figure 1 depicts the increase in exploration, resource and reserve announcements issued to the ASX from December 2004 to December 2008 (Figure 1 is based on analysis by Bird, Grosse, & Yeung, 2013).

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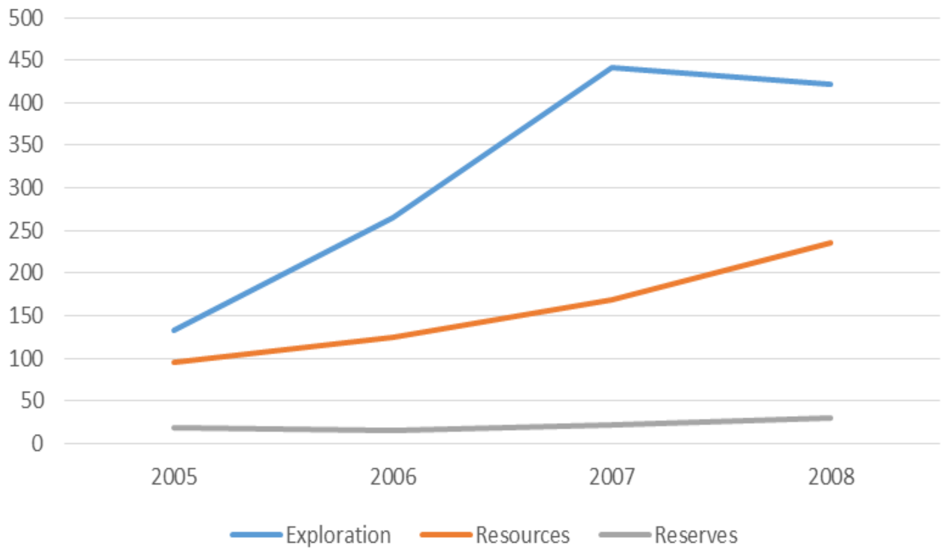
[3] BRIC is an acronym for the combined nations of Brazil, Russia, India and China – four nations which, given the relatively large size of their economies, were (until recently) commonly employed to represent the sustained high economic growth rates evident for much of the developing world over the past few decades.

[4] In framing this research, it is advisable to acknowledge potential biases. The author's work experience is grounded in the ASX. This familiarly is reflected in a tendency to draw examples that relate to the ASX. Nonetheless this research is global in orientation, consequently, all examples employed herein illustrate features of the NRS considered to be of global applicability.

[5] This assertion follows from the fact that only a small number of NRCs have delisted or entered insolvency under the supportive influence of a commodity price super cycle.

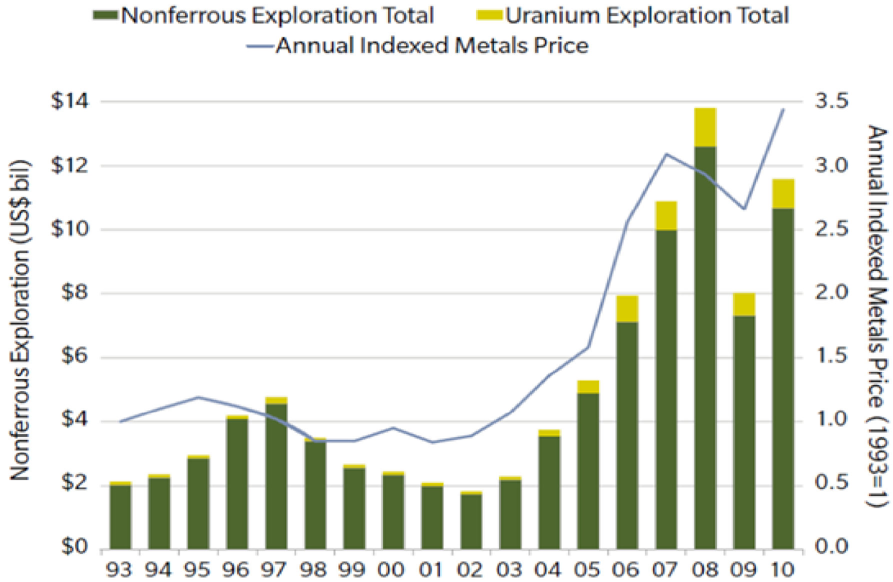
Figure 1 – ASX exploration, resource and reserve announcements



Based upon data from Bird et al. (2013)

Moreover, investment inflows to the NRS have grown exponentially. On a global basis, this is reflected in the dramatic upsurge in exploration expenditures, commeasure with rising metal prices, since the early 2000s. The rise in exploration expenditures, despite a temporary reversal in the wake of the Global Financial Crisis (GFC), as depicted in Figure 2.

Figure 2 - Global exploration expenditures and metal prices



Adapted from Metals Economics Group (2011), as cited by Law (2011)

Yet, while the NRS, in terms of number of companies, news flow, and the investment capital it attracts, has grown rapidly under the tailwinds of the commodity price super cycle, there has not, arguably, been a comparable increase in investment knowledge concerning the NRS. This research seeks to bridge, to some degree, this disconnect. Moreover, this research is motivated by, focussed upon, and occurs in the context of, a booming NRS. This extends to the empirical analyses conducted under this work, which are centred on the period captured by the commodity price super cycle.

1.6.2 Sector-specific Research

Catalysed by the commodity price super cycle, the NRS has rapidly risen in prominence and in its contribution to the world economy. The research in this thesis represents a sector-specific study. Though sector-specific studies, by definition, reduce both sample size and generalizability they hold several advantages over wide-ranging, multi-sector analyses (Riley, Pearson, & Trompeter, 2003). A key advantage is coherence with the modus operandi of practising analysts who tend to specialize in one sector owing to the presence of sector-specific idiosyncrasies. Moreover, sector-specific studies provide an opportunity to present nuanced and sector-specific insights - an advantage general multi-sector studies cannot hope to emulate. For instance, sector-specific analyses provide the capacity to control for the broader economic context as it relates to that specific sector (Quirin, Berry, & Bryan, 2000).

1.6.3 Venture-capital Research

Along with it being a sector-specific study, this research can more generally be viewed as a variant of venture capital research. Specifically, the NRS, dominated by companies focussed upon exploration and the development of embryonic resource projects, is analogous to the broad concept of venture-capital: NRCs adopt business strategies involving high-levels of uncertainty for the chance, albeit very small, of an immense return. [6, 7] In this vein, Cranstoun (2010, p.2) notes, for the case of NRCs without operational mining assets: “A junior mining company has no mining operations and is essentially a venture capital company”. Consequently, this research contributes to a broader field of research that is not NRS-specific, but rather focussed on those situations

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[6] In keeping with the seminal work of Knight (1921), this study recognises the subtle but important differences between risk and uncertainty. Specifically, the former involves a knowable distribution of outcomes and the latter connotes an outcomes distribution that, prior to the outcome, is entirely or mostly unknown or unknowable.

[7] Thus, this research treats the NRS as a subset of venture-capital. As such, this work applies the term ‘venture-capital’ somewhat more loosely than is usual practice. The similarities between venture-capital and the NRS are many, and are detailed in Chapter Two. However, NRCs as defined under this research (for a complete definition, again refer to Chapter Two) do differ from the usual definition of venture-capital in several respects; in particular, venture-capital typically relates to private (unlisted) companies and often entails that its investors (venture-capitalists) contribute across more than the financial dimension, for instance, by influencing the company’s strategic direction.

where an economic shift creates enhanced opportunities for some sector that stimulates an explosion of venture-capital concerns seeking to capitalise on that sector's enhanced opportunities. A leading example of such phenomena in modern times would be the dot-com bubble that marked the passage of the 21st Century. Catalysed by advances in computing technology, in particular the internet, the dot-com bubble oversaw a boom in the computer technology space. Consequently, a swathe of essentially venture-capital companies listed on global equity markets during this period seeking to capitalise on the perceived potential of the new technology. These dot-com companies largely confounded orthodox valuation, in a manner comparable to the mysteries of market valuation in the NRS. The rich ferment embodied by a cluster of venture-capital companies jostling to harness the opportunities of a new economic reality is an area of interest in this thesis.

1.6.4 Fundamental Analysis

As a sector-specific study focussed on the venture-capital dominated NRS, the primary objective of this research is to investigate how valuations for NRCs are imputed by the market. In order to achieve this task the study tests PVFs, as suggested by the literature, and considers how the PVFs interact to determine the market value of NRCs. Such an approach places this work under the broader intellectual mantle of fundamental analysis.

Penman (2009), as cited in Richardson et al. (2010, p.423), succinctly defines fundamental analysis as "the analysis of information that focuses on valuation." Accordingly, fundamental analysis embraces both accounting and non-accounting information about a company and its place in the economy to infer that company's *intrinsic value* (Graham & Dodd, 1934; Graham, 1949). This valuation process is conducted independent of any quoted share price (Quirin et al., 2000). It is often contended that intrinsic value, as assessed by the analyst or stock holder, need not concur with market value. However, assuming that the intrinsic value has been correctly determined, it is generally contended that intrinsic and market value will be in harmony, at least on average and over the long run (Graham, 2006). The extent to which intrinsic and market value are in harmony is commonly referred to as the 'efficiency' of the market.[8]

[8] There is a spectrum of viewpoints concerning the efficiency of markets, or the degree to which market prices fully reflect all available information. Notably, the facility with which the empirical analysis under this study can be conducted is partly a function of the degree of market efficiency within the NRS.

Security Analysis (Graham & Dodd, 1934 & 2009), and subsequently, *The Intelligent Investor* (Graham & Dodd, 1949 & 2006), heralded the popular establishment of the fundamental analysis tradition. Over the ensuing three-quarters of a century, the fundamental analysis tradition, as originated with Graham and Dodd, has been advanced and amended to suit a variety of novel contexts. For instance, employing baseball statistics to identify under-priced baseball players, as showcased in the book *Moneyball* by Lewis (2003) and subsequent Hollywood film of the same name.

Fundamental analysis is now an established line of research within finance with the earliest academic work conducted by Ball and Brown (1968) and (Beaver, 1968) aimed at testing the value-relevance of accounting information to market value. The work of these researchers was prompted by various criticisms and doubts at the time regarding the potential of accounting statements to convey value-relevant information given the historical-cost basis of such statements. Ultimately, the work of Ball and Brown (1968) and Beaver (1968) vindicated the value-relevance of accounting information. Since this time academic work has successfully extended this line of research, emphasising the value-relevance of accounting information in many different contexts and venues.

The accounting-centric focus of the fundamental analysis literature is exemplified by Ou and Penman (1989), who exhaustively dissected financial statements in a search for possible predictors of earnings changes, within a one-year time horizon. In this effort Ou and Penman (1989) were criticised because the predictive financial signals identified were the product of a systematic data-mining of financial statements. Thus, many of the financial indicators identified were considered to provide little theoretical or even post hoc intuitive insight. In addition, the pertinent signals uncovered varied with the period under consideration and no justification was provided for that period specific variation. Furthermore, the identified signals were pooled together into a single measure, in order to test the resulting predictive power. This meant that the significance of any one signal in isolation was lost and it also left the study vulnerable to criticisms of over-fitting and

Presumably, if the market is more efficient, the 'connection' between information and market prices will be stronger and, by implication, the statistical results will be more significant. Such a presumption does assume that the value-relevant factors identified in the literature closely approximate the information actually employed by the market. However, if the market is efficient to the extent that even private information is embedded in the market, so-called 'strong-form efficiency,' the statistical analysis employed herein will be hampered to some degree, as this research seeks only to link market price to publicly available information.

multicollinearity biases. However, (Bernard, 1989) defends this approach by arguing that Ou and Penam (1989) deliberately chose such a methodology to ensure that the value-relevance of their identified accounting factors was not due to hindsight bias.

The artificial signal selection process utilized by Ou and Penam (1989) was disconnected from definitive theoretical foundations. In contrast, Lev and Thiagarajan (1993) based their selection procedure on a survey of the professional stock-analyst establishment. The Lev and Thiagarajan (1993) paper was also a milestone in the fundamental analysis literature because it tested its selected factors with respect to the broader macroeconomic context. Lev and Thiagarajan (1993) showed that most of the factors identified were significantly related to a firm’s market valuation while aggregating the value-relevant factors yielded a measure indicative of future earnings (Bauman, 1996). A potential methodological flaw which arises through surveying professional analysts and cross-referencing these identified factors with the theoretical and empirical literature is the weak systematic thoroughness which was the touchstone of the Ou and Penam (1989) study. This raises the potential spectre of omitted-variable bias which may impede the validity of the regressions Lev and Thiagarajan (1993) utilised. Thus, the surety of testing factors supported by professional practise and economic literature was achieved by sacrificing systematic rigor, the hallmark of the Ou and Penam’s (1989) study, who necessarily made the opposite trade-off.

This research follows the style of Lev and Thiagarajan (1993) in that it allows for the macroeconomic context and selects its PVFs based on the beliefs of experts in the field. Nonetheless, while Lev and Thiagarajan (1993) crosschecked the validity of their selected PVFs against the relevant literature, they sourced their PVFs through a survey of the professional stock-analyst establishment. In contrast the PVFs in this research derive solely from a comprehensive review of the theoretical and empirical literature. Nevertheless, the approach adopted herein is a spiritual descendent of the pioneering work done by Lev and Thiagarajan (1993), in that this research also derives its PVFs from the opinions of experts in the field of equity valuation, but rather than a survey, these opinions were sourced from the received literature.

Amir and Lev (1996) represents another watershed in the fundamental analysis literature, being the first study to take a sector-specific focus, whilst also pioneering an emphasis on non-accounting value-relevant factors in tandem with the more traditional accounting-based factors. Focussing upon the wireless communications sector, Amir and Lev (1996) found that non-accounting factors possessed superior value-relevance as compared to accounting factors, although accounting factors also complemented and supported an explanation of market value. While the validity of these findings are somewhat impeded by the small sample size and methodological issues associated with survivorship bias, the study does point to the usefulness of adopting a holistic approach embracing both accounting and non-accounting factors rather than simply considering accounting factors in isolation (Amir & Lev, 1996). Wallman (1996) has supported this notion advocating that accounting statements be augmented with pertinent non-accounting factors in order to help stakeholders make better informed decisions with respect to the future performance of firms. Accordingly, this research is in the lineage of Amir and Lev (1996): a sector-specific study inclusive of both accounting and non-accounting PVFs.

Aside from recognising the value-relevance of both accounting and non-accounting PVFs, the fundamental analysis influences this research in other important ways. In particular, PVFs are restricted to those factors that can be assessed in a systematic fashion. In other words, only those PVFs that can be quantified are included in this work. This systematic emphasis reflects a continuing theme in the fundamental analysis tradition as reflected in its seminal works. In this vein, Schroeder (2008, p.126 & 127) notes:

> "Graham's book" was The Intelligent Investor, published in 1949…blew apart the conventions of Wall Street, overturning what had heretofore been largely uninformed speculation in stocks. It explained for the first time in a way that ordinary people could understand that the stock market does not operate through black magic. Through examples of real stocks such as the Northern Pacific Railway and the American Hawaiian Steamship Company, Graham illustrated a rational, mathematical approach to valuing stocks. Investing, he said, should be systematic.

Consistent with this founding principle of fundamental analysis (i.e. objectively quantifiable metrics) this research necessarily excludes a number of PVFs vouched for by the literature. The primary PVF excluded under this research, because it evades ready quantification, is company management. This is despite the fact that company management is often esteemed as a leading PVF within the NRS (e.g., Kennedy, 1996) with some professional sources even arguing that a company's human capital is the *most* important factor in valuing a junior mining company. For instance, (van Eeden, 2006b) contends:

> "Exploration companies don't have assets, cash flow or earnings. They typically only have a management team, sometimes a bit of cash, and one to several properties. The cash will get spent, usually a lot quicker than anticipated. Their projects aren't assets: they are liabilities where the cash is going to get spent. That leaves us with management, and management is absolutely an exploration company's biggest asset -- if not its only asset."

Indeed, management's human capital is ubiquitously credited with a company's ultimate success.[9] Nonetheless, human capital, that idiosyncratic synthesis of vision, charisma and willpower possessed by a company's senior management team, and its impact on market value, is a notoriously difficult factor to quantify. Consequently, this research eschews company management as a PVF.[10] Such a decision is in accord with fundamental analysis generally, even traced back to its earliest roots. Indeed, again invoking Benjamin Graham's method, probably the earliest exemplar of fundamental analysis, Schroeder writes (2008, p. 143 & 144):

> "Graham did it mainly through his skill at analyzing numbers. Before him, assessments of a security's value were largely guesswork. Graham developed the first thorough, systematic way of analyzing the value of a stock. He preferred to work by studying only public information – usually company's financial statements – and rarely attended even public meetings with a company's management."

Pointedly, in the words of Graham himself (2006, p.293), "On Wall Street a great deal is constantly said on this subject, but little that is really helpful. Until objective, quantitative, and reasonably reliable test of managerial competence are devised and applied, this factor will continue to be looked at through a fog." Despite the passage of more than half a century, this research adopts a similar position, namely that the quality of management does not lend itself to systematic quantification, and thus, is not deemed a PVF and is consequently outside the ambit of this research.

Notably, given the exclusion of company management, it might seem somewhat incongruous that speculation is nonetheless included as a PVF under this research. However, as will be explained in Chapter 6, speculation often manifests itself in the NRS through the medium of other PVFs, particularly commodity-type and drilling results. By implication, speculation in the NRS is considered capable of, albeit indirectly, at least to some degree, quantification and, therefore, systemisation.

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[9] Robert Friedland is a current example of a dominant personality, albeit controversial, and creator of vast fortunes in the mining industry. Incidentally, while force of personality is an individual trait, there is suggestion that, through mentorship and other means, it can be learned. Indeed, the unique personality traits that characterised Steve Jobs, the founder of Apple Inc., at present the most valuable publicly listed company in the world, have been partly credited to the influence of Robert Friedland (Isaacson, 2011).

[10] For consideration of how managerial reputation can influence the NRS with regards to the pricing of capital raisings see Iddon, Hettihewa and Wright (2013).

1.6.5 Theoretical Foundations

Grounded in the fundamental analysis tradition, this research's theoretical foundations lie, at root, in the concept of valuation. Specifically, valuation represents the theoretical foundation to this research because this research is concerned with how equity markets impute the value of NRCs. Thus, this research is focussed on relating information (i.e. PVFs) to market value (rather than intrinsic value which is not objectively observable). Insofar as the field of finance is concerned, company value is considered a function of future cash flows discounted for the risks and uncertainties associated with those cash flows (Parker, 1968; Roberts, 2000). Such a conception is formalised in the generic practice of DCF and NPV analysis (Lonergan, 2006). Notably, Fisher (1930) is generally credited with formalising such cash flow analysis in terms of modern economic thought. Thus, this research adopts the basic Fisherian concept that a NRC's market value is a product of its future cash flows discounted for the risks and uncertainties associated with these cash flows and, by implication, that present market value is related to future value. Thus valuation, as the term is employed in modern finance, represents the theoretical foundation underpinning this research.

1.6.6 Section Summary

In summary, this section has framed the research by identifying the business context and impetus for the research: the commodity price super cycle and concomitant flourishing of the NRS. Accordingly, this section categorized the research as a sector-specific study, focussed as it is upon the NRS. Moreover, given the nature of the NRS, embroiled in massive uncertainty for a miniscule chance of massive recompense, this research identifies the sector as an example of venture capital; thus, it is contended that this study represents a case-study of venture capital more broadly. Moreover, the primary research heritage from which this work is descended, fundamental analysis, was discussed alongside the work's theoretical foundations.

1.7 Chapter Summary

This introductory Chapter has established a gap in the literature as being: the mystery as to how the market imputes value to NRCs. Limitations encumbering the extant literature were discussed and the way in which this research helps to bridge, to some degree, these limitations was identified. Finally, this Chapter has located the research within the broader business context and streams of scholarship in which it resides. The subsequent Chapter builds on these foundations by precisely demarcating the subject of this research, the NRS.

1.8 The Structure of the Thesis

This section outlines the structure of the thesis, of which there are thirteen chapters. Following this introductory Chapter, Chapter 2 frames the research by defining the NRS and characterising the sector's distinctive nature. Given the NRS's distinctive nature special valuation methodologies have been developed for the sector and these are also expounded in Chapter 2. In addition, limitations hampering these extant valuation methodologies are discussed. Having established the essential subject matter Chapter 2 concludes by heralding the importance of the NRS and by implication the research. This is achieved by considering the sector's role in the global economy, its contribution to new resource discoveries and developments as well as its contribution to the larger natural resource houses.

Having laid the groundwork for the research in Chapters 1 and 2, the body of the thesis, Chapters 3 to 11, comprises literature reviews and statistical analyses of PVFs within the NRS. Notably, Chapters 3 to 11 each focus on a particular category of PVF, as detailed in this section. Nonetheless, while Chapters 3 to 11 are each focussed on a specific category of PVF, it will sometimes be necessary, in discussing a particular category, to allude to PVFs from other categories. This is because, while the demarcation of PVFs into nine discrete categories is a useful organising construct, the categories of PVFs are, in practice, interrelated insofar as valuations in the NRS are concerned.

Chapter 3 examines accounting-based PVFs. Accounting-based PVFs are deemed a fitting point of departure for the research given that the value-relevance of accounting information is the foundation of the fundamental analysis tradition. Accordingly, Chapter 3 commences with a review of the literature to identify accounting-based PVFs of pertinence to the NRS. Subsequently, the accounting-based PVFs identified are statistically tested using a large sample of NRCs sourced through Intierra (2011). A panel data methodology (fixed-effects model) is employed to conduct the statistical analysis.

Chapter 4 investigates capital raisings. Capital raisings, as previously noted, are critical for NRCs in order to secure the cash infusions needed to finance future activities. Notably, this Chapter respects the distinction between the IPOs and SEOs as discrete forms of capital raisings. Moreover, Chapter 4, in reviewing the capital raisings literature for the NRS, notes the relative paucity of research on SEOs as compared to IPOs. To help remedy this imbalance, Chapter 4 conducts statistical analysis into SEOs as they apply to the NRS. This analysis is again based upon data supplied from Intierra (2011) and, to identify the relevant PVFs, involves an event study methodology in complement with multiple regression analysis.

Chapter 5 considers stage-of-development. Typically, NRCs at more advanced stages-of-development command higher market valuations. It is shown that stage-of-development is itself a PVF within the NRS because it provides information about: (1) the magnitude and timing of future cash flows and, (2) the risks and uncertainties attached to those cash flows.

Chapter 6 considers PVFs associated with speculation. Speculation, as the term is applied in this work, denotes substantial divergence between market value and intrinsic value. The potential for speculation is shown to be especially acute with the NRS given the convergence of a number of factors. It is argued that speculation in the NRS is generally made manifest through two categories of PVF, namely, commodity-type (discussed in Chapter 7) and drilling (the subject of Chapter 10).

Chapter 7 studies macroeconomic PVFs within the NRS. The NRS is a consummately global business and so macroeconomic factors represent a prominent category of PVF. Principal PVFs to emerge from the literature include exchange rates, the buoyancy or otherwise of global equity markets and commodity prices. Indeed, the value-relevance of commodity prices is empirically confirmed through the statistical panel data analysis conducted in Chapter 3.

Chapter 8 considers PVFs associated with feasibility studies. To introduce the topic, Chapter 8 discusses the role and value-relevance of feasibility studies generally. Notably, feasibility studies draw together all relevant technical and financial factors relating to a resource and are employed to vindicate a resource's economic credentials and source necessary finance. The Chapter then delves into specific PVFs associated with feasibility studies.

Chapter 9 considers PVFs associated with resources. Resources are the asset base upon which the NRS's business model is centred. Specifically, NRCs are engaged in the search, development and exploitation of resources. Thus, the PVFs discussed herein are considered elemental to the valuation of NRCs.

Chapter 10 concerns itself with drilling and PVFs to arise from drilling. The ultimate purpose of drilling is the resolution of uncertainty and, by resolving uncertainty, drilling represents an essential category of PVF. This is especially true given that the overwhelming majority of the NRCs comprising the NRS are exploration-focussed. Indeed, according to the literature, an exploration-focussed NRC who is yet to enjoy exploration success is analogous to an out-of-the-money call option.

Chapter 11 deals with PVFs relating to a NRC's projects. Projects represent geographical areas in whose borders NRCs hold legal rights to resources. Specifically, the property rights endowed by projects are the mechanism by which NRCs accrue value derived from current mining operations or future mining operations. Consequently, the value-relevance of resources and hence related categories of PVFs, such as feasibility studies and drilling, is ultimately predicated on projects. Important PVFs related to projects noted include their location with respect to available infrastructure and prevailing sovereign risk levels.

Chapter 12 seeks to represent, in holistic fashion, how all the PVFs identified in Chapters 3 to 11 interrelate in concert to determine the market valuation of NRCs. This is achieved through the creation of a novel and unified conceptual framework which maps market values in the NRS as a function of the interactions between PVFs. Thus, Chapters 3 to 11 address the first of the two subsidiary research questions directing this research, namely: "What are the PVFs within the NRS suggested by the literature?" Building on this work, Chapter 12 addresses the second subsidiary research question, namely: "How do the PVFs interrelate in context to determine the market value of NRCs?" By this path the primary research question directing the research is answered, namely: "How does the market value NRCs?"

Chapter 13 concludes the thesis. The gap in the literature, the resulting research questions, and the method adopted to answer these research questions are noted. Additionally, the contribution to knowledge, limitations to the research and some opportunities for future research are discussed.

Chapter 2: The NRS

2.1 Chapter Introduction

This purpose of this chapter is to describe the NRS and the context in which the sector operates. Specifically, the first section defines the NRS in order to make explicit what the subject matter under investigation is. Subsequently, the distinctive characteristics of the NRS are enumerated. This is important because, as a sector-specific study, it is vital to clarify what separates the sector under investigation from the broader market. The next section outlines valuation methodologies that have been developed to appraise companies in the NRS. Overviewing the available valuation methodologies is requisite given the focus of this research: the valuation of NRCs. Finally, the importance of the NRS to the broader economy is articulated. By demonstrating the importance of the NRS, the importance of research in the vein of this work is underscored.

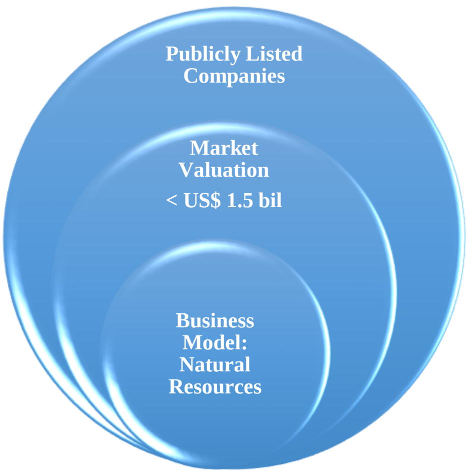
2.2 Defining the NRS

At the outset of any research it is advisable to precisely define the unit of analysis under investigation. The unit of analysis underlying and focusing this research is the NRC. Collectively, the population of NRCs comprise the NRS, the broader subject of this research. For the purposes of this research, a NRC is defined by three delimiting characteristics, namely, a NRC:

(1) Is publicly listed;
(2) Holds a market valuation less than US$1.5 billion;
(3) Has a business model that is focussed on some combination of finding, developing and mining natural resources.

The nexus of these three characteristics captures the universe of NRCs – the elemental unit of analysis underlying this research (refer to Figure 3).

Figure 3 - The nexus of the Venn diagram demarcates the NRS



2.2.1 Listed Companies

Only companies publicly listed on the equity markets are included in this research. This restriction stems from the relationship underlying the investigation, namely, the relationship between market value and value-relevant information, and the need to source information pertaining to this relationship as a prerequisite to empirical analysis. Finding the market value for publicly listed companies is generally straight-forward, with the public exchanges providing securities trading, and hence a market value, on at least a semi-continuous basis. However the task of sourcing similar market value information for privately listed companies is usually impractical. Furthermore, the task of sourcing information regarding PVFs is problematic for private companies, especially given their predilection for confidentiality. However, the task is made more amenable for publicly listed companies due to regulated requisites for the disclosure of information judged ‘price-sensitive’ to the equity markets.

2.2.2 Market Valuation

This research focuses on firms with market capitalisations of less than US$1.5 billion. Excluding companies with market capitalisations in excess of US$1.5 billion is not, as might first appear, an overly restrictive filter, given that approximately 98 percent of the NRCs in the NRS have a market capitalisation under US$1.5 billion.

The NRS is not homogeneous—one clear demarcation occurs at or near the somewhat arbitrary market capitalisation of US$1.5 billion. Specifically, the 98 percent of NRCs who hold market valuations under US$1.5 billion are, overwhelmingly, in the realm of venture-capital (e.g. focussed on exploration and/or the development of embryonic and/or marginal resource projects). The small subset of active miners who hold market valuations below US$1.5 billion are generally focussed on a single, or small collection, of mines in a limited geographical domain. Similarly, miners below the $1.5 billion cut-off, generally, derive their revenue from a small collection of commodities, or even a single commodity. In contrast, the two percent of NRCs with market valuations above $1.5 billion are, with a few exceptions, diversified miners with a portfolio of mines encompassing an array of commodity-types and geographical regions. Due to the surety such diversification grants to earnings, this latter group of NRCs typically have easier access to debt markets and a lower cost of capital. Therefore, the primary difference between the two groups of NRCs on either side of the US$1.5 billion market-valuation dichotomy is diversification; NRCs holding market valuations above US$1.5 are generally far more diversified than NRCs holding market valuations under US$1.5 billion.

Given that the US$1.5 billion figure is somewhat arbitrary, it cannot be inferred that a NRC with a market valuation marginally below this figure is by any quantum, less diversified then the NRC with a market valuation marginally above this figure. However, given that market valuation follows an exponential function within the NRS, the US$1.5 figure is pragmatically chosen, with the small minority of NRCs holding market valuations greater than this figure dominated by more diversified firms, including the world's behemoth diversified miners, such as BHP Billiton, Rio Tinto, Xstrata and Anglo American. In contrast, NRCs with market valuations below $1.5 billion are, almost universally, firms with very low levels of business diversification. In addition, due to this fundamental difference in diversification separating NRCs on either side of the US$1.5 billion divide, companies with market valuations below US$1.5 billion generally hold far fewer assets and liabilities (for instance, fewer exploration and developmental projects, simpler balance sheets). This, from a research methodological standpoint, makes the task of statistically analysing PVFs with respect to one another far more amenable. For these reasons this research only examines NRCs with market valuations under US$1.5 billion.

2.2.3 Business Model

The generic business model of NRCs is to source, either through exploration or acquisition, natural resources, and then develop these natural resources into productive mines such that positive cash-flows are generated. By 'natural resource,' this study adopts the definition of a 'mineral resource' employed by *The Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves* (hereafter referred to as 'JORC Code'; JORC, 2012, p.11) as:[11]

> "…a concentration or occurrence of solid material of economic interest in or on the Earth's crust in such form, grade (or quality), and quantity that there are reasonable prospects for eventual economic extraction. The location, quantity, grade (or quality), continuity and other geological characteristics of a Mineral Resource are known, estimated or interpreted from specific geological evidence and knowledge, including sampling."

Once a resource has progressed to the point that there is sufficient knowledge to establish that it is likely economic to mine, it is categorised as a 'reserve'. Notably, this research employs the term resource in a general sense, to encompass resources that are

[11] The JORC Code is prepared by The Joint Ore Reserves Committee which draws its members from three bodies: (1) The Minerals Council of Australia, (2) The Australasian Institute of Mining and Metallurgy, and (3) The Australian Institute of Geoscientists (Joint Ore Reserve Committee, 2014).

known reserves and those not yet so categorised. Thus, the standard business model of a NRC is to discover or acquire a resource and transition it into a reserve that is either developed into mining operation or sold to a firm willing to engage in that development.

However, some would also argue that the business model of many NRCs is, based on the strength of their resource discoveries and developments, to become an acquisition target for larger companies and thereby create shareholder value. One NRC succeeding in this way would be Diamond Fields, who, in August 1996 was acquired by Inco for CAD$4.5 billion on the strength of a nickel discovery in Newfoundland, Canada. That same month, another NRC, Arequipa, was acquired by Barrick for CAD$1.1 billion following excellent gold intersections in Peru (Brown & Burdekin, 2000). Alternatively, some NRCs pursue more individualistic, maverick business strategies. For example, Franco-Nevada Corporation, from a NRC, pursued a strategy of buying mining royalties – especially in gold miners – and snowballed the strategy over several decades to become a multi-billion dollar enterprise (Condon, 2002). Regardless, the business model of a NRC remains fixated on resources – and their successful development. Moreover, for the purposes of this work, the standard business model of the NRS will be the assumed – and will inform the overall structure of this work.

Table 1 - Stages-of-development for a NRC

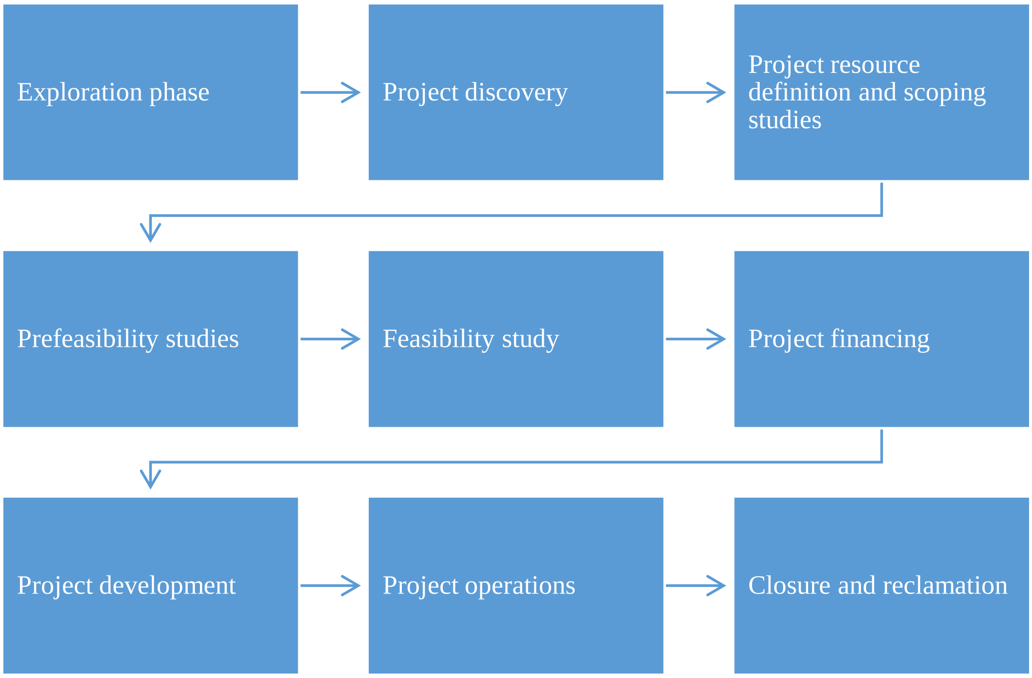
Phase	Name	Aim
1	Mineral Exploration	Explore to discover a resource of economic interest
2	Feasibility Study	Perform the necessary work to prove its commercial viability
3	Mine Development	Engineer and construct the necessary infrastructure
4	Mining	Extract ore from the ground
5	Mineral Processing	Milling of the ore; separation of the ore from the gangue material; separation of the ore minerals into concentrates
6	Smelting	Recover metals from the concentrates
7	Refining	Purifying the metal
8	Marketing	Ship the product (or metal concentrate if not smelted and refined at the mine) to the buyer
9	Closure	Clean up and remediation of mining and smelting sites

Adapted from Evans and Moon (2006)

In executing the standard business model, a NRC progresses through a number of developmental stages, with a NRC's stage-of-development at any given time largely defining its activities and focus. The principal stages-of-development involved in executing this business model are outlined in Table 1. Notably, given that the vast majority of NRCs are at a relatively early stage-of-development, most NRCs are focussed upon mineral exploration and feasibility studies.

In order to validate this depiction of stages-of-development as those standard to the NRS several other authorities are presently drawn upon. For instance, a parallel representation of the successful developmental arc for a NRC, adapted from Nethery (2003), is presented in Figure 4.

Figure 4 - Comparable representation of a NRC's stages-of-development

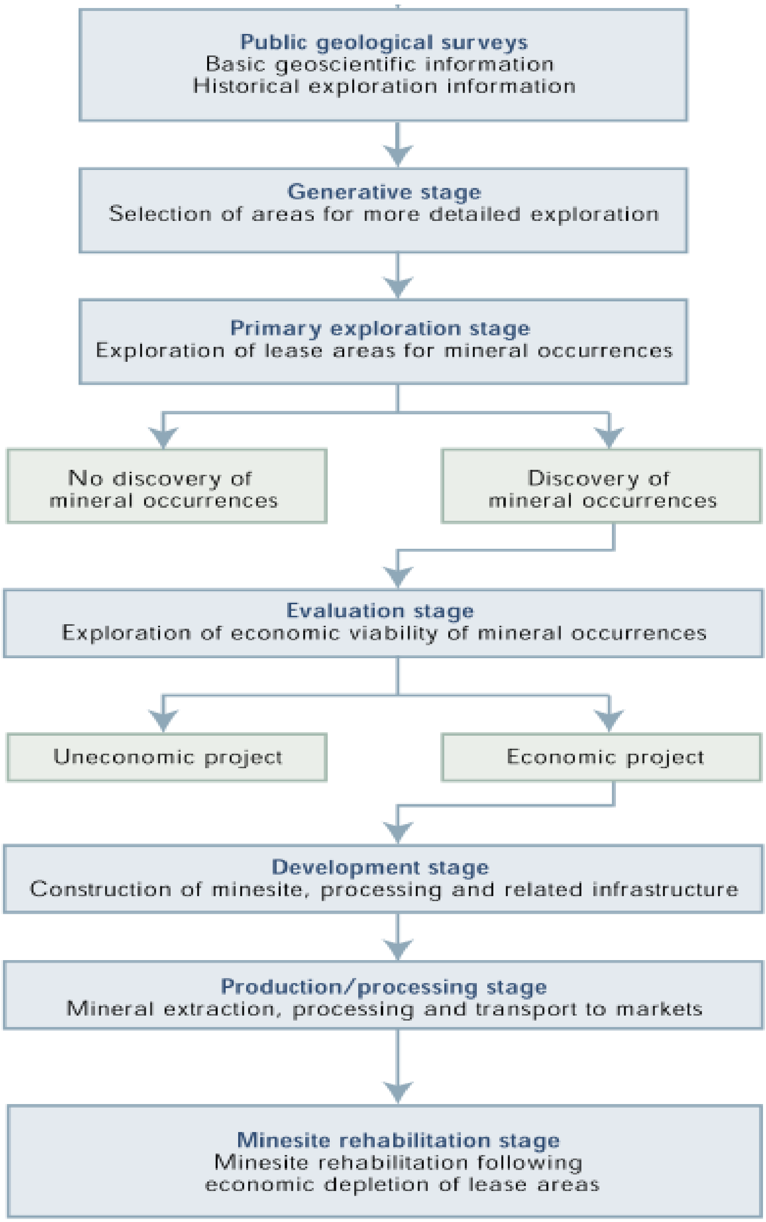


Adapted from Nethery (2003)

A final analogous representation of the stages-of-development involved in a NRC's business model is depicted in Figure 5. Thus, there are a number of alternative, approximately equivalent, taxonomies by which to represent the various stages-of-development in the NRS, depending on the authority consulted.

In addition, there exists a wide assortment of different commodity-types, and combinations thereon, which may comprise any particular natural resource. The principal commodities of interest to the NRS, as determined by the (Intierra, 2011) database, are as follows: bauxite, bismuth, chromite, coal, cobalt, copper, diamonds, gold, heavy mineral sands, ilmenite (titanium-iron oxide), iron ore, lead, limestone, lithium, magnetite, manganese, molybdenum, nickel, niobium, palladium, platinum group elements, phosphate, platinum, potash, rare earths, rhodium, silver, tantalum, tin, titanium, tungsten, uranium, vanadium, yttrium, zinc and zircon. The primacy of these commodity-types is established by Table 2 which presents, based upon data from Intierra (2011), commodity-types for which there are at least thirty companies exploring, developing or mining. Table 2 presents the number of companies and projects involved in each of these primary commodity-types as of December 2011. Thus, these commodity-types form the primary focus of the NRS, and, by implication, it is these commodity-types which form the focus of this research.

Figure 5 - Analogous representation of a NRC's stages-of-development



Adapted from Hogan et al. (2002)

Despite encompassing the gamut of principal commodity-types, a notable exclusion from this research is oil and natural gas companies. The primary reason for this omission is that oil and natural gas companies were not represented in the secondary data upon which this research is based. Moreover, there are sound fundamental reasons to partition oil and gas from a more general analysis of the resources sector. Rudenno (2010) emphasises the fundamental differences between the oil and gas sector compared to the wider resource sector; differences evident in the various stages-of-development, from exploration drilling, resource estimation, extraction through to processing. A key factor underlying this separation is articulated by (Craighead, 2010):

> "A major factor differentiating the Oil & Gas sector from the remaining resources sector is the risk and cost structure of the industry. Exploration drilling, particularly offshore, is expensive but discoveries can be brought on-stream relatively quickly and have a low operating cost structure. This contrasts with a major base metal discovery which could take 10 years from discovery to development and first production. Hence, share price leverage to exploration success is generally higher than other parts of the resources sector."

Table 2 - The primary commodity-types in the NRS

Commodity	Number of Companies	Number of Projects
Bauxite	43	194
Bismuth	48	66
Chromite	59	133
Coal	244	1,218
Coal (Coking)	74	312
Coal (Thermal)	139	759
Coal (Coking and Thermal)	51	192
Cobalt	321	727
Copper	1,806	6,336
Diamonds	265	713
Gold	2,438	12,663
Heavy Mineral Sands	49	181
Ilmenite	40	125
Iron Ore	467	1,552
Lead	979	2,199
Limestone	36	97
Lithium	131	234
Raw Magnetite	247	501
Magnetite	135	225
Manganese	132	263
Molybdenum	567	983
Nickel	685	1,913
Niobium	83	112
Palladium	232	500
PGEs plus gold	42	146
PGEs	248	431
Phosphate	104	219
Platinum	266	566
Potash	82	190
Rare Earths	277	494
Rhodium	36	109
Silver	1,577	4,959
Tantalum	91	132
Tin	126	223
Titanium	63	109
Tungsten	158	253
Uranium	662	2550
Vanadium	126	219
Yttrium	60	72
Zinc	1,161	2,892
Zircon	40	117

Based upon data from Intierra (2011)

2.2.4 Section Summary

In sum, the NRS, as it is defined under this research, comprises the population of publicly listed companies holding market capitalisations below US$1.5 billion, seeking to discover or acquire, develop, and mine any of the major commodity-types—except oil and gas (which, while related to the NRS, has sufficient key differences to require its classification as a separate sector).

2.3 Distinct nature of the NRS

The NRS was explicitly defined in a previous section. This section seeks to enunciate what distinguishes the NRS from the broader market. Such distinctions are important because sector-specific studies which focus on a sector that is not especially idiosyncratic are likely to yield findings which can easily be subsumed in more generalised models (Sloan, 2001). Hence, this section argues that the NRS must be investigated on its own terms; otherwise researchers risk excessively abridging and over-simplifying the richness of that sector. This section explicitly outlines characteristics that differentiate the NRS from the broader market. In total seven factors are identified as making the NRS a unique market sector. The first five of those factors are common to venture-capital generally; while these characteristics are a function of the unique operating environment of the resources business, the characteristics are roughly analogous to venture-capital. In contrast, the last two factors are specific to the NRS and establishes that while the NRS is a variant of venture capital, it has key distinctive features.

2.3.1 Extreme Uncertainty

In common with venture-capital more broadly, the NRS is marked by an extreme uncertainty-to-reward profile: ultra-uncertainty is offset by returns that can be stellar, albeit improbable. Initially, this section enumerates those factors which give rise to the ultra-uncertainties of the NRS. Finally, this section considers why, on certain occasions, the NRS is so utterly conducive to incredible returns.

A partial explanation for the heightened uncertainty present in the NRS is that many NRCs are relatively new entrants to the equity markets who, consequently, are yet to establish themselves and their corporate identity; let alone, a cash-flow and earnings profile. Stinchcombe (1965, p.148) coined the phrase “liability of newness,” to denote the inherent millstone that youth engenders in companies. Pointedly, a preponderance of NRCs only débuted on the equity markets in the wake of the recent commodity price super cycle and, furthermore, these companies oftentimes had only limited operating histories as private entities prior to public listing. Thus, a component of the heightened uncertainty associated with NRCs is attributable to their youth as corporate entities.

Still, the ultra-uncertainties that imbue the typical NRC are present from the earliest through to the latest stages-of-development. For instance, the available research suggests that exploration may be an irrational investment decision, even for many renowned exploration addresses. This is evidenced by Mackenzie and Woodall (1988) who compared base metal exploration in Australia from 1955-78 and in Canada from 1946-77. The study concluded that while mineral exploration in Canada was lucrative it was uneconomic in Australia, given that the cost of economic discovery in Australia was four times that of Canada. While the rationality of exploration can be a function of location, research by Mackenzie and Dogget (as cited in Evans, Whateley, & Moon, 2006) demonstrates that it can also be a function of the commodity-type pursued. The Mackenzie and Dogget study revealed that, in aggregate, gold and nickel exploration in Australia from 1955-86 was a profitable undertaking while base metal exploration over the same time period destroyed more value than it created. More recent research conducted by Lord, Etheridge, Willson, Hall, & Uttley (2001) on the history of resource discovery in the Laverton region of Western Australia revealed that, once the time value of money was taken into account, the entire process destroyed more value than it created. This is a stark conclusion, given that exploration is a leading and foundational activity for most NRCs. Even the founder of modern economics, Adam Smith, speaking from the 18th century, warned of the dire risks involved in the exploration process (Smith, 2005, p.252):

> "Of all those expensive and uncertain projects, however, which bring bankruptcy upon the greater part of the people who engage in them, there is none, perhaps, more perfectly ruinous than the search after new silver and gold mines. It is, perhaps, the most disadvantaged lottery in the world, or the one in which the gain of those who draw the prizes bears the least proportion to the loss of those who draw the blanks; for though the prizes are few and the blanks many, the common price of a ticket is the whole fortune of a very rich man."

More recently, Mackenzie and Doggett (1992, cited by Poskitt , 2005) estimated that the likelihood of a mineral occurrence eventuating to become an economic resource is in the order of 1-2 percent. The immense uncertainty associated with the exploration process is emphasised by (Morton, 2009):

> "Discovery of an ore deposit is partly luck and may always be so - why is this fault mineralized while the other 10 in the area are not. The answer may be that that's the random fractal path the fluid decided to take on its way to the surface-very difficult to reconstruct ancient fluid pathways. Thus geology can put you in right area, can define and narrow targets, but a discovery hole is definitely partly luck. This is shown by the successes ratio in exploration which is much less than 1%."

A case in point is the discovery of Olympic Dam, the world's largest uranium deposit and fourth largest copper deposit, in addition to Australia's largest gold deposit. The discovery of Olympic Dam by Western Mining included some six years of target generation before the first drill hole encountered copper, albeit sub-economic, in 1975. More discouraging still, the following eight holes were barren, and at this point the exploration effort might have been abandoned. Yet Western Mining persisted and finally, on the tenth hole, economic copper and uranium was encountered. Nevertheless, the following six holes also resulted in further disappointment and it was not until 1978, when three more consecutive economic intersections were achieved, that Western Mining was able to claim a major discovery (Upton, 2010).

Even once a significant economic discovery is achieved, and a decision to mine finalised, special sector-specific uncertainties remain throughout the various stages-of-development. These include procuring finance, resolving environmental protection regulations and native title issues, securing power and water supplies, enduring vicissitudes in commodity prices and currencies and overcoming a myriad of other technical, logistical, legal, social and operational challenges (Rudenno, 2010). Wellmer, Dalheimer, and Wagner (2008, p.20), summarising a study by Sillitoe (1995) warn:

> "Many exploration projects have a chequered history with many owners. Sillitoe (1995) examined the history of 53 Circumpacific producing base- and precious metal mines. Only a third went from discovery to the stage of producing mine in one go, meaning with one company, for the second third two attempts were necessary, and for the last third up to 11 different companies tried their exploration luck and only the last one was successful to bring the deposit into production.

Even when projects are successfully developed into a mine, it is estimated that less than 20 percent are finished within budget and on schedule (Benning, 2000). In fact, even when mining finally starts, uncertainty, rather than subsiding, can actually peak; cash flows are threatened as production begins due to ubiquitous 'teething problems' – at precisely the time when the NRC's debt burden are greatest (Benning, 2000). Ironically, sometimes attempts to mitigate the ultra-risks to which NRC are heir to can morph into the ultimate source of the NRC's destruction – as demonstrated by the hedging book blowups that precipitated the collapses of Pasminco and Sons of Gwalia (Ferguson, Clinch, & Kean, 2011). NRCs, Jackson observes (1993, cited in Ballard & Banks, 2003, p.294), "are by no means as omniscient or as fiendishly clever as they are usually depicted but are capable of the same lack of foresight and blessed with the same proclivity to create monumental stuff ups as everyone else."

Another source of uncertainty afflicting investors is clandestine: the possibility for some NRCs to act unscrupulously or even fraudulently. The susceptibilities of the NRS to fraudulent behaviour are considered by Naylor (2007, p.89), “because such schemes routinely promise fantastic returns; partly, too, it is because precious metals have a special lure based on myth, magic or even atavistic religious appeal which con artists exploit.” While NRCs ostensibly exist to profit shareholders, some commentators (such as Sykes, 1978) conclude that many company directors in the sector are more interested in mining their shareholders’ pockets than resource projects. An example, not of outright fraud, but of the exploitation of investors’ short memories and perennial greed, concerns gold ore in the Queen Charlotte Islands of Canada. The Queen Charlotte Islands gold boasts some of the highest concentrations in the world; however, the minable ore bodies are only a few cubic metres. Every decade or so a NRC makes a ‘spectacular’ discovery on those islands, sells lots of stock based on the preliminary drill results, that promptly collapses after secondary drill results show that the total deposit is of only meagre dimensions (Iddon & Hettihewa, 2010). This example draws into sharp relief the ambiguities between outright fraud and an honest attempt by a NRC which eventuated in failure, an ambiguity abetted in no small measure by the uncertain nature of geological theory (Naylor, 2007).

Still, despite the uncertainty maelstrom facing investors, the substantial streams of capital upon which the NRS depends are sourced because, like venture-capital generally, investors are attracted to the potentially massive gains, however unlikely, that the sector can incubate. For example, despite research suggesting that exploration is, at least in certain contexts, a net loss-making activity, investors are often irresistibly drawn to the possibility, albeit remote, of an economic discovery and the immense wealth such a discovery will likely bequeath to the NRC’s original shareholders. It is this possibility, this potentiality, this idea which ultimately stirs the imaginations of investors and drives them to invest when there are, up until now, no tangible certainties; only phantasms and wisps of future prospects suggesting instant and vast wealth creation. Thus exploration and the valuation of exploration companies is, almost by definition, based less on the tangible and more on an idea or more precisely a forlorn hope. Hence, at least in the case of NRS exploration, the primary force seducing investors, despite the perils facing invested capital, is the possibility of participating in the next mega-mine discovery.

Imagination, while intangible and mercurial, is elemental to the NRS investment universe; the allure of undiscovered resources, like the ‘buried treasure’ of folklore, although difficult to quantify, is often an intoxicating stimulant for the appetites of investors. The excitable imaginations engendered by 'discovery potential,' although not generally represented on the balance sheet, form the principal asset for many NRCs and, thus, forms the substratum of investment behaviour within the NRS.[12] Consequently, the NRS is a wellspring for perennial speculative bubbles. In fact, the JORC Code (2012) and the earlier editions of the Code previously discussed were created in an attempt to temper the NRS's proclivity for speculative boom-bust episodes, following the Poseidon Boom of the late 1960s/early 1970s (Camisani-Calzolari, 2004).[13] Poseidon NL, a hitherto obscure NRC, led the eponymous Poseidon Boom following feverish speculation over its nickel sulphide discovery at Mt Windarra, Australia. This discovery occurred in the context of an ebullient nickel market: the Vietnam War had increased the demand for nickel while, concurrently, supply was constrained due to industrial action at Inco, a major Canadian nickel producer. On the promise of the Mt Windarra discovery, Poseidon shares vaulted from less than \$1 to \$280 over a four month period, transfixing the attention and imagination of the market at the time. However, despite commencing underground mine development, Poseidon NL failed to meet the insatiable expectations woven around it. The dramatic rise and fall of Poseidon NL's share price is depicted in Figure 6. Although Poseidon NL produced nickel in 1974, it was beleaguered by lower than expected nickel prices and grades, compounded by extraction difficulties that led to a gradual descent that tipped over into a death spiral that culminated with the firm's delisting in 1976 (Sykes, 1978).

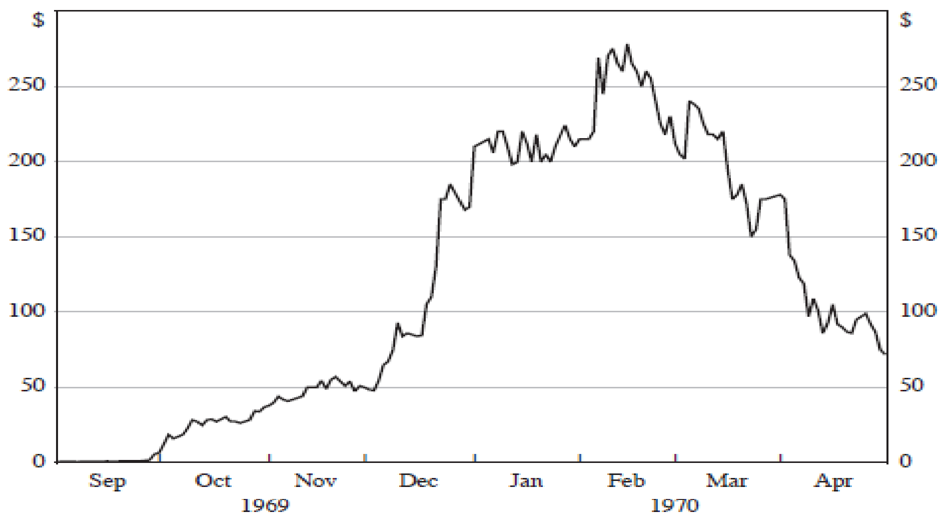
Another notable NRC to become embroiled in the rampant waves of speculation enveloping the market during the Poseidon boom was Tasminex NL. On 27 Jan/70, shares in Tasminex NL multiplied from \$3 to \$96, over a mistaken belief that the Company had discovered nickel sulphides in a Greenstone Belt of Western Australia. The hysteria evoked over Tasminex NL was sparked on the Australia Day weekend when one of the Company's directors collected rock chip samples from some water boreholes the Company had drilled. Panning these rock chip samples the Company Director uncovered what he thought could be nickel sulphides. Although a geologist on site was sceptical, the potential new find was communicated to Tasminex NL's Chairman who, in turn, extolled

[12] The speculative excitement that can result from discovery potential is represented on a balance sheet when, based at least in part on the speculative atmospherics, a NRC is acquired by another company. In these cases, the premium paid in the takeover is captured on the acquiring company's balance sheet as good will – an intangible asset. Under these circumstances a component of good reflects the speculation engendered by the discovery potential.

[13] The JORC Code was first issued in 1989 (Joint Ore Reserve Committee, 2014).

the potential discovery to a rapacious marketplace. On the following Tuesday, the first opportunity for the market to trade after the long weekend, Tasminex stock rose dramatically in ferocious trading, from a previous close of $3.30 to a new closing price of $16.80. In London that night English traders supported this meteoric trajectory with the stock trading to its zenith of $96. Over the following few trading days, the share price corrected to $40, helped by Tasminex directors themselves selling stock and, by Mar/70, shares were trading at $7.50. As the Poseidon boom subsided, the reality that Tasminex had not found nickel was realised, and a disillusioned market lost interest (Sykes, 1978).

Figure 6 - The Poseidon share price bubble



Source: Australian Financial Review, as cited by (Simon, 2003)

Whilst the tremendous gains of Poseidon NL and Tasminex NL turned out to be transitory, the NRS boasts a sufficient number of more permanent success stories to sustain investors' optimism. For instance, in reviewing top performing shares on the ASX over the previous 20 years, (James, 2011) found that Fortescue Metals Group, in its transition from JMC to market leader, had yielded the best returns by an incredible margin: rising at an average rate of 12,431 percent per annum or 248,624 percent over the study period. The extreme uncertainty-reward profile (quintessential to the NRS), thereby, serves to stimulate the imaginations and cupidity of many investors, whether the euphoria is fleeting, as in the case of Poseidon NL and Tasminex NL, or more enduring, as in the case of Fortescue Metals Group.

The extreme uncertainty-reward relationship of the average NRC is reflected in the extreme uncertainty-reward profile of the sector: the distribution of market valuations and returns within the NRS is dominated by a small minority of highly successful NRCs. Such a skewed industry profile is partly explained by the geological distribution of resources, with both resource sizes and grades exhibiting a lognormal distribution (Sinclair, 1977 as cited by Albanese, 1981). For example, Davis (1973 as cited by Albanese, 1981) confirms that silver mines in Mexico follow a lognormal distribution and Williamson (1974 as cited by Albanese, 1981) confirms that this is also the case for Malaysian placer mines. Another case in point is the Cloncurry-Mt Isa region in Queensland Australia, quoting J.H. Brooks (1990, as cited by Pohl, 2011, p.419):

> "The distribution of formerly exploited copper deposits and mineralizations in the Cloncurry-Mt Isa district provides an instructive example. Apart from the world class Mt Isa deposit, 262 sites produced >10 t, 70 >100 t, 14 >1000 t and only 6 including Mt Oxide … yielded >10,000 tonnes of copper."

Hence, the upper echelon of resource discoveries and developments, as measured by size and grade, capture most of the wealth to be derived in aggregate from all resources. It follows that the select group of NRCs who own these superlative resource projects will enjoy the greatest wealth creation opportunities and market valuations. Thus, the NRS affords investors an environment with extreme uncertainty-reward relations, much like venture-capital more generally.

2.3.2 Risk Capital

Another commonality between the NRS and the broader class of venture-capital is a reliance on risk capital. The NRS is indentured to risk capital because the Sector is predominately composed of companies at a nascent stage-of-development who, accordingly, have no mining operations and, by implication, no earnings. Without earnings these NRCs have no recourse to internally generated funds and must rely on the external capital markets. For such NRCs the capital raising process is not auxiliary to business operations but is, like venture-capital more broadly, a necessary precondition to any business operations. This latter point is illustrated by Kreuzer, Etheridge and Guj (2007) who studied junior exploration floats on the ASX from 2001-06. They found that the typical junior explorer raised Au$4 million during the IPO process, but, given an average annual cash-burn rate of Au$2.6 million, usually required fresh capital within two years of listing. Thus, the capital markets act as umbilical cord for the vast majority of NRCs during their protracted incubation phase that precedes raw material production and earnings.

The NRS's dependency on risk capital most typically manifests itself through equity raisings. Indeed equity financing is the primary source of capital for NRCs. The dominance of equity raisings vis-à-vis debt financing reflects the extreme uncertainty-reward relationship that suffuses the NRS: generally only equity is willing to partake in the high uncertainties to which the NRS is heir as only equity can hope to share, commensurately, in the potential high rewards. The popularity of equity raisings to the NRS is also attributable to the fact that equity raisings are the quickest method for procuring funds (Low, 2011). Speedy finance is desirable as it makes possible a key advantage of NRCs over their larger competitors: rapidity and mobility in exploiting new opportunities as and when they arise. Consequently, the NRS is heavily reliant on equity markets; the capacity to periodically tap equity markets is essential to the continued business development of NRCs, and, moreover, their survival as going-concerns.

Given the NRS's requirement for risk capital it follows, by definition, that the sector is perilous for investors. Research by Brown, Farris and Jefferson (1979, as cited by Lawritsen, 1993) examined the junior mining industry from 1965-1977 under a buy-and-hold strategy and found that the likelihood of losing money was approximately 80 percent. Moreover, comparing the total investments in the sector over the period and the value of those investments in 1978, it was found that the average net loss on investment was 57.8 percent (Brown, Farris & Jefferson, 1979). Indeed, out of a total 3,411 financings conducted during the period, only 275 (~8 percent) were able to achieve a 20 percent return over a period of four years (Brown et al., 1979). Thus, capital invested in the NRS is well termed risk capital; from the research of Brown et al. (1979) almost half a century ago to the present the NRS remains a risky maw for investment capital.

Therefore, at least for those NRCs at an early stage-of-development, there is a profound dependence on external capital markets, predominantly equity markets. Nevertheless, there is a small minority of NRCs who do operate mines and accrue the earnings derived from these productive assets. NRCs operating mines garner, aside from internally generated funds, access to a wider store of external capital raising options, in particular debt. Kennedy (1996, p.6) emphasises this distinction:

> "Companies that have operating mines generally have a regular cash inflow from which to fund further exploration. They also usually have access to debt capital because they have assets (proven mineral resources) and anticipated future cash flows (from mining) necessary to secure loans. They do not face the same critical time constraint as exploration companies."

Nevertheless, even the small subset of miners included within the NRS typically depend on risk capital – that is, on capital subject to a heightened uncertainty-reward relationship; albeit, an uncertainty-reward relationship somewhat moderated from that of a NRC at an earlier stage-of-development. This is due to the inherent uncertainties involved in the mining process and the non-diversified status of these NRCs who operate mines. Thus, in generally, the NRS is dominated by firms who depend upon risk capital.

Risk capital is inherently mercurial. Consequently, the ease with which NRCs can access this capital is highly variable. In regards to the mining industry Low (2011, p.2) notes, "The cyclical nature of the industry makes the risk-return profile of financings more difficult to estimate than in other industries." This reflects the reality that risk capital is highly mobile and not bound to any one industry or segment of the economy. Rather, for any given moment in time, risk capital is flowing to where investors' perceive the optimal location for their risk capital to be. In this vein Hogan et al. (2002, p.22) ponder the potential substitutive role different industries with an analogous venture-capital profile may hold:

> "In recent years, there have been increasing difficulties for junior explorers in accessing equity markets. Given their risk profile, junior exploration companies typically obtain external financing through the equity markets and in particular the speculative end of the equity markets. For much of the past five years other industries such as biotech and the dotcoms have appeared to offer the prospect of better returns than mineral exploration and may have attracted speculative capital away from minerals exploration."

Thus the NRS, as a subset of venture-capital more generally, is dependent on risk capital, a form of capital typically accessed through equity markets, involving high uncertainties for the potential, albeit unlikely, of huge returns, and whose accessibility itself is unstable.

2.3.3 Intangible Assets

Yet another feature of venture-capital shared by the NRS is the special significance of intangible assets. Such an assertion is, prima facie, somewhat paradoxical given that the mining industry is arguably the most 'tangible' of all businesses: the mining industry supplies the raw physical materials demanded by the wider economy. However most of the NRCs that comprise the NRS are involved in exploration and the activity of exploration is conducted on exploration tenure, which is itself a variety of intangible asset. Exploration tenure is an intangible asset because, prior to discovery, exploration tenure holds no demonstrable resources – only the possibility that it may hold resources. As exploration tenure contains no, as of yet, defined resources, no prediction of future cash flows can be reliably arrived at. Therefore, the only value which can be affixed to exploration tenure is its options value, that is, the possibility that it holds resources of economic significance. But determining this option value is largely a product of subjective judgement – based upon geological theory and exploration hypotheses that may, or may not, prove correct. Thus exploration tenure, a core focus for most NRCs, is a fundamentally intangible asset.[14]

Fundamentally, the value attributed to an exploration tenement is a function of the perceived strength of the geological theories suggesting its prospectivity. The perceived strength of such geological theories are themselves largely a function of other intangibles, particularly intangibles relating to human capital, such as the creativity of the NRC's geologists in formulating the geological theories, and the charisma of the NRC's management in promoting these theories to potential investors. Thus, for those NRCs at an early stage-of-development, intangibles infuse the entire business model.

Frequently, the amalgam of exploration tenure and geological theory initiates vast value-creation, as exemplified in the case of 'Carlin Style Gold,' also known as 'invisible gold'—a style of deposit composed of extremely tiny grains of gold which, owing to their diminutive size, are extremely difficult to detect. In fact, Carlin style gold is too small to be concentrated through panning. As a result, the '49ers on the Emigrant trail to the goldfields of California traversed veritable mountains of Carlin style gold in Nevada without ever suspecting the hidden troves of treasure trodden beneath their feet. Prospectors in the late 1800s also missed the area's potential. The discovery of the Carlin deposit in 1961 by Newmont Mining Corporation, currently the second largest gold producer in the world, marked an early step in the Company's ascension to pre-eminence. Newmont commenced production from the Carlin deposit in 1965. Newmont Mining Corporation were the mavericks who, knowing that occurrences of invisible gold had been documented elsewhere, hypothesised, based upon the underlying geology, that this area in Nevada was prospective and, on being proved correct, created vast value. Ultimately, the 'Carlin Trend' yielded more than 20 deposits, and helped transform Nevada and the United States into one of the world's leading gold producers (Coope, 1991). While quantitatively estimating the value of Newmont Mining Corporation's

[14] Given the marginal and potentially negative economics of exploration, in many contexts, it is perhaps more accurate to categorise exploration tenure as a liability. Nevertheless, whether asset or liability, exploration remains, for much of the NRS, the best chance of success and the primary drawcard for investors. As a result this research categorises exploration tenure as an intangible asset.

Carlin discovery was possible once a resource had been established, and, even earlier, once gold had been confirmed within assays, any such valuation was not practical while the gold remained an unproven and 'invisible'. Yet it was fundamentally this intangible exploration notion which produced a vast flood of tangible gold.

As such, geological hypotheses can initiate vast value creation and/or valuation shifts for many exploration-focussed NRCs. As the exploration process advances, a NRC's exploration hypotheses are scientifically tested through, for instance, the drill testing of anomalies conjectured to signify economic ore bodies. Confirming evidence tends to increase the market's valuation of a company, while refuting evidence can have the opposite effect. Still, as in science generally, serendipity often plays a role. Specifically, in a few cases the refutation results in an entirely different commodity-type and style of deposit than the Company was actually pursuing. In such cases, while the NRC's exploration hypothesis proved erroneous, the exploration process these hypotheses initiated, nevertheless prove lucrative.

Thus, at least in the case of exploration, value is based less on the tangible than on the intangible. Exploration is a search for a potential but unknown resource and funding is needed for that search. Attracting these funds usually requires masterful storytelling that typically invoke heroic predictions and initiate paradigm shifts which draw the NRS dream further into the domain of the intangible. It is intriguing how the discovery of an economic resource is often described within the industry as a 'company maker'. This term may reflect the commonly held belief that a NRC does not graduate to 'Company' status, at least in a permanent sense, until its ethereal ideas and exploration possibilities are proven-up and commercialised. Such is the case for venture-capital, where the idea and the development of that idea is fundamental, and must necessarily precede earnings. Hence, like venture-capital generally, much of the value ascribed by the market to a NRC is represented by intangible assets.

2.3.4 Protracted Pre-production Timelines

Another aspect that the NRS holds in common with venture-capital are extended periods in pre-production and/or pre-earnings. Even once an exploration effort is fruitful, (e.g. an economic resource is discovered) the time-line to production can be upwards of a decade. For example, in the previously discussed Olympic Dam case, despite Western Mining finally being in a position to claim a major discovery in 1978, it was not until

1988 that production could finally commence (Upton, 2010). However, major expansions to that project planned in 2007 by BHP Billiton (the new owner of WMC Resources, as of 2005) were shelved in 2012, due to environment concerns and weak commodity prices (Mining Technology, 2014). As of 2014, BHP Billiton was still reconsidering how new technology and a redesign might make the expansion more viable (Mining Technology, 2014). In a more extreme example, technical obstacles led to a four decade delay in the development of the McArthur River lead-zinc project (Mudd, 2010). According to (Mulholland, 2010), in the case of base metal deposits in Australia, analysis indicates that the average time, from discovery through to development, is approximately twelve years. These protracted periods in pre-production augment the ultra-uncertainty involved in the sector, given that discount rate used in estimating the present value of long-term investments is especially sensitive to the adverse effects of risk and uncertainty. Thus, like venture-capital generally, the complete value of a successful investment in the NRS, from discovery through to production, can only be derived after the passage of time has reduced and/or revealed the true risk from behind the fog of uncertainty.

2.3.5 Market Valuation Volatility

Another characteristic the NRS shares with venture-capital is extreme volatility in market valuation. Indeed, Rudenno (2010) asserts that resource stocks possess twice the share price volatility of industrial companies. This heightened volatility in the market valuation of resource companies reflects, to some degree, volatility in underlying commodity prices. As NRCs are producing commodities, or seeking to produce commodities, a positive association between commodity prices and the market valuation of NRCs is logical (Rudenno, 2010). Thus, the ultra-volatility of commodity prices is a leading explanation for the ultra-volatility observed in NRS market values. In fact, Jacks, O'Rourke and Williamson, (2011) found that commodity price volatility has significantly exceeded manufactures price volatility over the past three centuries. The ultra-volatility of commodity prices is partly a product of the renowned cyclicality of commodity markets. Some argue that this commodity price cyclicality is a function of capital market myopia: where an investment viewed in isolation appears to be sensible, but is actually unsound from a broader perspective that considers the collective outcome of other such 'sensible' individual investments (Sahlman & Stevenson, 1985). More specifically, it is argued that rising commodity prices encourages increased investment in new mine production but, owing to the considerable lag before new mines can come on-stream, investment may be excessive, yielding a surplus of supply in the future and a cyclical reversal in price. The ensuing protracted depression in commodity prices forces the high-cost marginal producers to close and, moreover, tends to elicit chronic under-investment which eventually result in rising commodity prices in a self-sustaining pattern of cyclical boom-busts (Forster, 2005).

In addition, signature activities of the NRS, particularly exploration and resource development, are deemed especially conducive of higher degrees of volatility. Evidence for this assertion comes from studies investigating the impacts of research and development (R&D) expenditures. In particular, R&D (a ubiquitous element of venture-capital) is considered to be highly analogous to exploration and resource development in that both involve large capital expenditures over protracted periods of time for an uncertain payoff, namely, the hope of securing a monopoly position over a productive asset. Studies that suggest a positive association between R&D expenditures and volatility include Chan, Lakonishok and Sougiannis (2001).

Excessive volatility may even be wilfully engineered by certain NRCs themselves. O'Shea, Worthington, Griffiths and Gerace (2008), in an investigation of small to mid-capitalisation resource stocks on the ASX, concluded that many companies employ frequent and repetitive market announcements to increase share price volatility and, thereby, draw market interest. The presumed intent behind such self-promotion is to increase market price. Empirical support for such a bridge between volatility and improved market prices includes Duffee (1995), who found a positive correlation between stock volatility and stock returns. Reinforcing this potential, Grullon, Lyandres and Zhdanov (2012, p.1500) find that the positive correlation between volatility and stock returns is especially strong for, "…young firms, small firms, high R&D firms, and high growth firms," – all characteristics associated with the NRS. Further, Grullon et al. (2012) provides perhaps the most persuasive rationale for the observed positive correlation between volatility and stock returns. Specifically, Grullon et al. (2012) argue that firms with plentiful real options will enjoy higher returns when the underlying processes exhibit increased volatility because firms can proactively make operational and investment decisions to ameliorate downside volatility while maximising the benefits of upside volatility. For example, a NRC might hold the option of developing a marginal resource project should commodity prices prove more favourable in the future – in this instance the real option being the marginal resource project and the underlying processes represented by movements in the commodity price. The NRS, dominated by such real options, rather than assets in place, will therefore generally reward higher returns to firms with increased volatility. Still, the argument espoused by Grullon et al. (2012) is based upon; volatility in the underlying processes enhancing market value and thus producing a positive relationship between volatility and return. As such, it is not self-evident that a NRC capable of self-engineering increased market price volatility, without enjoying simultaneous volatility in the underlying processes, would also enjoy improved future returns. Consequently, as is the case for venture-capital generally, market valuation in the NRS is subject to more volatility than the broader market.

2.3.6 Non-renewable Resources

Having enumerated five characteristics possessed by the NRS and venture-capital more generally, attention is now paid to a characteristic unique to the NRS: a business model founded upon the exploitation of non-renewable resources. The mining of finite resources is the principal means by which the NRS derives earnings; consequently, unlike other sectors, the principal asset underlying the NRS, mines, are exhaustible. Mines are the consummate depreciating asset; every mine has a mine-life, the point at which the economic portion of the resource has been exhausted and beyond which the mine's closure is, at least eventually, necessitated by low profitability.

The non-renewability of resources seems to undermine the potential lifespan of a NRC, if its primary asset is, by necessity, transitory. This question was pondered in the early 20th century by the Chairman of the board of Consolidated Gold Fields of South Africa (Kernot, 1999, p.195 attributed the following a 1911 statement by Lord Harris):

> "…some years earlier the directors had a discussion as to whether Gold Fields was to be a company with a terminable or, so far mundane things go, was it to have an interminable existence, and the board came to the conclusion that what the investing public would expect of such company as Gold Fields was that it should be interminable but we are a company which habitually invests in properties which have terminable lives."

The fundamental non-renewability of resources stimulates the activity of the NRS and delineates the sector's unique business model, particularly the exploration for and development of new resources. Indeed, the non-renewability of resources ensures that the NRS will evermore be in a state of dynamic flux; the sector is continuously motivated by the need to innovate in order to replace extinguished resources.

Pioneering research into the non-renewability of resources by Hotelling (1931) concluded that, while the generic firm would expand production until marginal costs equated marginal revenue, a mine must also take into account a vital opportunity cost, namely, that a unit of ore produced in the present will be unavailable for future production. This opportunity cost is the net present value (NPV) of the future profits foregone by the present production. If a mine's revenue does not surpass the marginal cost of production, plus the opportunity cost wrought by present production of a non-renewable resource, it will, eventually, cease production (Hotelling, 1931).

Nevertheless, in practise, such opportunity costs are generally of negligible relevance to the market, because production costs dominate to a level where opportunity costs are rendered immaterial (John E. Tilton, 2004). Another factor overwhelming the relevancy of opportunity costs, beside the primacy of production costs, is the risk that, with the passage of time, a resource left unexploited in the present may devolve to a non-resource in the future. That is, foregoing current production to increase future production may result in no production or earnings ever being derived. For instance, in the early part of the 20th century the valuable nitrate deposits of Chile declined precipitously in value as new technology created cheaper and better alternatives. Similarly, the discovery of superior iron resources in Australia and Brazil, in combination with rising high-volume/low-cost shipping, mothballed many iron resources in America and Europe (John E. Tilton, 2004). Asbestos is another example of this risk—it was a highly valued resource in the early to mid-20th Century, but by the last few decades of that century was increasingly vilified as a carcinogen and a cause of other lethal and debilitating diseases.

2.3.7 Taxation

An important implication of such a business model, based upon non-renewable resources, is that the NRS is often taxed more aggressively than other sectors of the economy. Hence such tax discrimination is also discussed. Specifically, governments generally tax mining companies more highly than other industries, with one of the primary justifications for this being that exploiting non-renewable resources involves an opportunity cost: mining non-renewable resources in the present disallows the exploitation of these resources by future generations. Hence, while the market does not value this opportunity cost to any real significance, governments generally do hold this opportunity cost in high stead in order to validate higher taxation of mining companies (Tilton, 2004). As an addenda to this issue, it is interesting to note that Simon (1996) asserts that new technology continually expands the availability of non-renewable resources by making us aware of new deposits and/or making formerly trace amounts of those non-renewable resources minable and smeltable. The Simon (1996) assertion was affirmed by Lomborg (2001, pp.137-148) and the (previously mentioned) 1965 discovery of Carlin Style Gold that prior to its discovery was “invisible” to prospectors.

Another leading rationale put forth to justify higher taxation of mining companies is that, while resources are generally the result of aeons of time and geological forces, some are especially rich and thus lucrative for their owners. It is, therefore, argued that such ultra-profitable resources, at the bottom of the resource industry’s cost-curve, can easily absorb a larger tax impost, whereas other sectors are perhaps more susceptible to the competitive nature of the global economy and thus are not able to weather similarly hefty tax burdens. Thus, it is often contended that taxation of ultra-profitable mines will not excessively interfere with economic behaviour, such as, the mining company’s rate of production; that is, taxing ultra-profitable mines is a tax on ‘Ricardian Rents’.[15] However, such an argument may be myopic. It ignores the reality that while particular miners may enjoy Ricardian Rents, the sector as a whole does not, due to the large aggregate losses absorbed by the NRS in exploring for and developing marginal resource projects. Thus, imposing a higher tax burden on NRCs will probably reduce the ultra-returns generally accruing to the discoverers and owners of ultra-resources. This may have the effect of reducing exploration expenditures in the long-term, thereby diminishing the sum of future world class discoveries and, in the process, narrowing the field of future taxpayers – particularly for those nations introducing disproportionate tax burdens on miners. Thus, while demanding higher tax receipts from miners may support windfall gains in the short-to-medium term it may also, on net, represent a long-term loss for the nation enacting such discriminatory tax systems.

Discriminatory taxation of resource projects is also more practicable for governments to effect than in other industries, because resources are immutably fixed to a particular geographical location. As resources are immobile the NRCs who choose to operate them cannot escape the ambit of government legislation. Still, mining companies are powerful social entities in their own right who can effectively manipulate national governments in select circumstances. For instance, the Resource Super Profit Tax proposed by the Australian Labour Government, in an attempt to capture a greater share of the profits from the mining boom, produced an effective counter-offensive and media

[15] The broader concept of Ricardian Rents is credited to the work of David Ricardo in the early 19th century – see, for instance, (Ricardo, 1971).

campaign by the mining industry in 2010. This was a major contributing factor credited with disposing of then Labour leader Kevin Rudd (Knox, 2013). This demonstrates that the mining industry can exert, especially in commodity-focused nations like Australia, considerable influence. Subsequently, the proposed legislation was revised and legislated after further consultation with leading mining firms and is known as the Minerals Resource Rent Tax. Still, some in the NRS have complained that the Minerals Resource Rent Tax favour leading mining companies to the detriment of smaller NRCs (Simon Bennison, 2011). Hence, taxation within the NRS remains contentious.

Despite such vociferations the majority of NRCs are not miners, and so have no meaningful earnings to tax. Nevertheless, even for NRCs who do not operate mines, there remain pertinent tax issues. For instance, in many important mining jurisdictions, such as Australia, miners hold an important advantage over non-miners. In particular, under the tax systems in these jurisdictions, miners can deduct exploration expenditure from their taxable income, thereby, subsidising their exploration expenditures, whereas NRCs who do not operate mines must fully finance their exploration expenditures. To remedy this inequality and thus stimulate the NRS, certain jurisdictions allow exploration expenditures, that cannot be deducted from the taxable income of the resource companies themselves, to ‘flow through’ as a personal tax-deduction to investors in these companies. Canada is one nation that encourages their NRS through such a flow through scheme, and this is a purported reason underpinning the many grass-roots exploration successes of this nation. Naturally, the Australian NRS is lobbying to close this tax-based competitive gap, through representative bodies such as Association of Mining and Exploration Companies (AMEC). Consequently, due to the non-renewability of resources, the NRS is vulnerable to differential tax treatment, and, given the powers arrayed on either side, this has been, and will likely continue to be, a major source of contention.

2.3.8 Section Summary

This chapter conceptualised the NRS as a subset of venture-capital, based upon the following commonalities: (1) extreme uncertainty, (2) a reliance upon risk capital, (3) the importance of intangible assets, (4) protracted pre-production timelines, and, (5) relative high market price volatility. Nonetheless, a chief distinction between the NRS and venture capital more generally is that, when a NRC successfully graduates to a miner, it is then operating an asset with a terminable life-span. An important consequence of this terminable life-span is, oftentimes, differential treatment by tax authorities. A more general consequence of the terminable life-span of mines is the existence of the NRS itself: as mines have finite lives there is a continual demand for new discoveries and developments: the supply of which the NRS helps satisfy.

Thus, the NRS can be conceptualised as an idiosyncratic subset of venture capital. In fact, owing to the idiosyncratic nature of the sector, specialised valuation methods have been created to account for the idiosyncratic nature of the NRS. These valuation methods are the subject of the next chapter.

2.4 Valuation Methodologies for NRCs

The distinctive nature of the NRS gives heir to a major feature of the NRS: a lack of authoritative valuation standards by which to appraise NRCs. Nevertheless, while imperfect, necessity has spawned a number of valuation methodologies by which to appraise NRCs. These valuation methodologies, and their inherent weaknesses, is the subject of this section.

Perhaps the most authoritative technique available to investors in the NRS is discounted cash flow (DCF) analysis. The notion that the value of any asset can be defined by the discounted value of its future cash flows is an old one (see, for instance Fisher, 1906). However, even DCF analysis, the ‘gold standard’ of equity valuations, is only reliable when applied to NRCs who have already delineated proven or probable reserves and who have completed a full feasibility study – prerequisites met by only a small fraction of companies within the NRS (Morley, 2007). Furthermore, even when a NRC is at a sufficiently advanced stage-of-development to admit DCF analysis, this valuation standard, despite being quantitative in nature, is nonetheless susceptible to subjectivity and bias (Lawrence, 2000). In fact, market pundit Padley (2009) argues that, although the net present value (NPV) projections of equity analysts are generally reliable indicators, they are of only marginal utility when applied to the natural resources sector. Padley (2009) contends that this is primarily due to the extreme volatility that besets the resource sector, with a multitude of largely unpredictable variables like commodity prices and exchange rates rendering the task of estimating future earnings a largely futile endeavour. Thus, DCF, while theoretically proper, is only as reliable as the ambitious predictions it is based upon, which, in the case of NRCs developing a resource towards a decision to mine include estimating such variables as future interest rates, commodity prices, developmental/production/sovereign risks and operating/capital costs.

Significantly, (Rudenno, 2004) has argued that this method is not as dubious as it appears prima facie because, though the estimation of any single variable may be wildly inaccurate, the overall process tends towards accuracy as, usually, projections which eventuate as overly pessimistic tend to be counterbalanced by projections that eventuate as overly optimistic. Thus, usually, NPV estimates are a reasonable approximation of a project's future economic outcome. Still, there will be a certain portion or projects for which the NPV projections eventuate, collectively, as overly pessimistic – and, in these cases, the project will generate unexpected windfall gains for its owners. Equally, there will be a certain portion of projects for which the NPV projections eventuate, collectively, as overly optimistic and, in these cases; the project will generate unexpected losses for its owners – sometimes even resulting in insolvency for the companies seeking to advance the projects. Thus, the pre-eminent valuation methodology, DCF, is generally inapplicable to the NRS – and, in the small minority of cases where DCF analysis can be applied – is by no means infallible. Far more fraught are valuation methodologies focussed upon appraising exploration acreage. Kennedy (1996, p.4) laments the difficulties involved in valuing exploration acreage:

> "These companies are not easy to study. The uncertainty associated with exploration makes it difficult to judge the value of companies during the exploration phase."

In fact Rudenno (2010, p.249) characterises the valuation of exploration acreage as:

> "In most cases the valuation, which is undertaken by the 'expert', will be very subjective, depending on the individual's expertise and experience".

Given that the majority of NRCs are exploration-focussed enterprises, an inability to value exploration acreage translates as an inability to value the majority of NRCs. The lack of authoritative standards by which to value exploration acreage is thus a fundamental problem afflicting the sector facilitating potential market inefficiencies. Consequently, common methodologies employed to value exploration acreage are discussed presently, while enumerating the chief limitations constricting their utility.

A common method adopted for valuing exploration acreage, in addition to resources, utilises the financial amounts paid for stakes in the underlying project, or in comparable projects, as evidenced by relevant commercial dealings such as joint ventures and farm-in arrangements. This family of valuation methodologies is known as 'comparable-transaction analysis' or 'farm-in-commitment analysis.' Though more market-attuned, this methodology is only as valid as the previous transaction it is based upon (Thompson, 2002). Thus, this valuation methodology furnishes no inkling as to how the intrinsic value for the asset underlying the previous transaction was determined. Hence, this method leaves the original conundrum unresolved, namely 'How was the price for the previous transaction, upon whose basis the current valuation is made, decided upon?' Such comparable transaction analysis is also practically impeded in practice because there are generally an insufficient number of truly comparable projects.

Another family of methodologies by which to value exploration acreage, as well as resources, bases its valuation upon the amount of expenditure on the project being valued - either historical expenditure or budgeted future expenditure or a mixture of both. Such a methodological basis is blatantly unsound because historical expenditure often yields disappointing results. Meanwhile, the link between future budgeted expenditure and future success is highly tenuous due to the remote statistical prospects of exploration success. In order to remedy this deficit more sophisticated systems have been developed to augment the methodology whereby positive results are afforded a premium valuation while poor results are assigned a discounted valuation. However the edifice wrought by this sophisticated system of premium or discount 'add-ons' is ultimately only as valid as the black-box of expert subjectivity of which it is comprised.

Alternative valuation methodologies seek to base their appraisals on underlying 'fundamentals' by seeking to 'rate' a project's value based upon the geological PVFs present. Thompson (2002, p.3) succinctly encapsulates such methodologies as: "wherein a geologist tries to convert subjective scientific opinions into a numeric engineering system". The Kilburn Rating Geoscience Rating Method is one popular methodology in this school (Kilburn, 1990). Limitations beleaguering such valuation methodologies include the fact that they remain quite arcane and, again, heavily dependent on subjective judgement (Australian Institute of Geoscientists, 2009; Thompson, 2002). The methodological basis of these valuation systems have also been questioned in some quarters, for instance, the Kilburn Geoscience Rating Method has been criticised because it applies a base financial value for every 16.2 hectares covered by the project under evaluation (Thompson, 2002). It is argued that blindly valuing exploration acreage based on area distorts any true indication of a project's underlying value because it places a premium on larger projects over smaller projects that may not be justified. There are other esoteric methodologies available - many of which are bedevilled by the root impediment identified by Lawrence (1994), namely "their lack of transparency mean's that they are variations on, "Trust Me – I'm a Valuer" (cited by Thompson, 2002, p.7).

A more specific, and highly sophisticated, method recently developed to rate geological factors and thereby value exploration acreage, which seeks to overcome many of the transparency issues, is the 'Geological Risk Method' developed by SRK Consulting (as cited in Morley, 2007). The Geological Risk Method involves determining the likely value which would accrue to a project if it is successfully advanced to the next stage-of-development, alongside the probability that the project's advancement to the next stage-of-development actually occurs. The stages-of-development for a project are conceptualised into the following series: project generation, reconnaissance, drill testing, detailed resource definition, feasibility study and mine. Determining the likely value which would be created by evolving a project to the next stage-of-development, alongside the probability of this successful evolution, is based upon rating various geological factors. In addition the Geological Rating Method considers the likely costs involved in metamorphosing a project to the next stage of its development. This method is designed to ensure transparency so that others can, with reference to the original assumptions, re-calculate a project using the Geological Risk Method and arrive at the same valuation. Therefore, the Geological Risk Method, as a methodology, demonstrates excellent reliability. Yet like all valuation methodologies within the NRS, the Geological Risk Method is mired by severe limitations. Some of the chief limitations undermining the method include heavy reliance on subjective judgement and the fact that its validity is contingent on the quality and quantity of previous research completed at the project (Morley, 2007).

Assuming a wider perspective, it is suggested that uncertainty is the very nature of exploration. As such, uncertainty is integral to the process of valuing exploration acreage – but this uncertainty is generally so overwhelming, and the odds of success so remote, that the methods available to appraise exploration acreage, despite considerable sophistication, are often of limited practical utility. The uncertainty, by its nature, thwarts all Procrustean methods which seek to convert, through some algorithm, the uncertainty into risk. Hence, the valuation of exploration acreage stubbornly remains more art than science. Consequently, exploration and the valuation of exploration acreage remain, perhaps necessarily so, a domain where imaginary possibilities flourish, where uncertainty, as opposed to risk, reigns. Consequently exploration, a creative trial-and-error process, fuels new mineral paradigms and discoveries, but, also, generally eludes attempts at robust valuation.

Also confounding valuation methodologies in the NRS is the evolving and unpredictable nature of the macro-economy – a factor that powerfully influences the NRS and, indeed, is a scourge for valuation system that attempt to represent the sector. Unless the valuation systems can, in fluid fashion, account for such unpredictable variability they often lose any correspondence to market realities. Indeed, the non-stationary nature of the NRS was bane of the sophisticated nomograms developed by Rudenno (2004). Such non-stationarity often then renders fixed systems designed to precisely explain equity values, at least over longer time periods, to obsolescence (Rudenno, 2004).

Thus NRCs at all stages-of-development are encumbered by a dearth of authoritative and robust valuation standards, but especially those at an early stage-of-development focussed upon exploration and the development of nascent resources.

2.5 Importance of the NRS

The previous section described the unique valuation methodologies that are applied to the NRS, this section sets out to demonstrate the sector's unique contribution. Indeed, it has been recommended that industry-specific studies demonstrate the significance of their chosen industry and thereby the significance of their study (Sloan, 2001). Following this counsel, this section demonstrates the significance of the NRS.

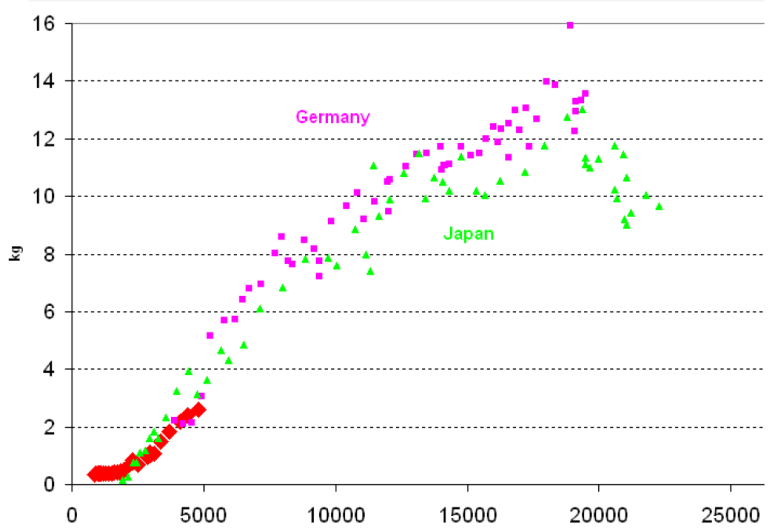
2.5.1 The NRS in the Context of the Global Economy

The NRS, as defined under this research, is the foundation of the larger resource sector. As already noted, the NRS is effectively a branch of venture-capital: encompassing the nursery-ground for many of the resource sector's future leaders. Thus, the NRS represents the innovative well-spring for the larger resource sector. The resource sector, in turn, is a central pillar of the larger global economy, given that the resource sector supplies the requisite physical materials for modern civilisation. By implication, as the elemental substratum of the larger resource sector, the NRS powerfully shapes the supply chains underpinning the global economy.

With the global economy in the midst of a commodity super cycle the importance of the resource sector, and its foundation, the NRS, has commeasurably increased. This commodity super cycle is being led by the increased rate of urbanisation and industrialisation in developing nations, most notably, at present, the BRIC nations. As these developing economies flourish and grow at a precipitous pace, elevating hundreds of millions from destitution and poverty, the requirement for the physical inputs which makes this growth possible continues to mushroom. In fact many commentators have declared that the rapid growth currently being experienced in the developing world, especially evident throughout Asia, to be the greatest mass exodus from poverty in the history of humanity (Easterly, 2008). The NRS is one of several forces underpinning and facilitating this economic growth, and, as such, in as far as it helps bring prosperity to the world's poor, is an important sector.

As illustration of the increased demand for raw materials this growth entails, consider the relationship, as per Figure 7, between per capita income (the horizontal axis) and per capita metal use (the vertical axis). Figure 7 depicts this relationship for copper with regards to two developed nations, Germany (depicted in purple) and Japan (depicted in green), and one of the rapidly developing BRIC nations: China (depicted in red).

Figure 7 - Per capita copper consumption as a function of per capita GDP



Häggström and Ericsson (2006, as cited by Ericsson, 2010)

Assuming that per capita copper consumption in China continues to track the historical experiences of Germany and Japan, and given the large population of BRIC nation's like China, the continued escalation in demand for copper, and supposedly other commodity-types, appears probable.

Given such rapid growth in per capita metal use in developing nations, like China, both occurring and predicted, coupled with the large populations of these developing nations, there is underway, at present, a quantum increase in the global economy's demand for raw materials. The task of supplying this burgeoning demand falls to the resource sector.

While the resource sector importance is currently rising in terms of commodity prices and volumes, the sector has always been vital to the development of human civilisation. (Johnston, 2010) notes that this dependency is recognised in the names given to civilization's stages-of-development, such as the Stone, Copper, Bronze and Iron Ages. Hence, while civilization's demand for resources has been a constant through human history, the underlying component resources demanded have continuously evolved. Even with the advent of the present Information Age, there is burgeoning demand for specific raw materials, such as rare earths and silicon (Johnston, 2010).

2.5.2 The Contribution to New Resource Discoveries and Developments

The task of supplying the escalating demand for raw materials is chiefly met by the global mega-mines, and the owner of these mines: the mining behemoths with market valuations in excess of $1.5 billion – that is, resource companies outside this study's purview. Yet, deeper inspection of the industry reveals the vital role of the NRS in meeting the global demand for raw materials, through the discovery of new resources and the development of marginal resources.

Research suggests that, with regards to discovering new resources, the NRS is, despite its relatively small size as measured by market value, considerable. In fact, the aggregate structure of the resources sector has evolved such that the business of exploration is, significantly, borne by the NRS. Meanwhile, the major resource houses focus upon the business of mining. Mitchell (2009, p.23) overviews the aggregate structure of the resources sector:

> "At first glance the wide range of organisations that make up the mining industry seem fragmented and disorganised. Organisations range from small entrepreneurial exploration companies–'juniors' –to major multinational companies. However, history has shown that the industry's structure is, in fact, an integrated and efficient production system with different types of companies occupying niches that are responsive to specific needs, opportunities and risks. Junior companies find new ore bodies and sell them to larger companies; 'intermediates' are typically formed to exploit a single deposit but often grow over time; intermediates offer potential for growth through mergers and may eventually become 'seniors', which provide the expertise, capital and risk management capacity to develop and operate major mines around the world."

The exploration responsibilities of the NRS are reinforced by Morton (2009, p.11), "many large companies no longer undertake mineral exploration programs or do detailed exploration - they buy deposits from junior companies which are financed by individual investors." Owing to the often marginal and even negative returns accruing to the exploration effort it is perhaps logical that the larger resource houses, whose performance and competitive position is largely a function of profitability, have generally tended to depart this investment space.

The overall structure of the resources industry, and some of the natural advantages NRCs hold in the exploration effort, are expounded upon by Ericsson (2010, p.7):

> "The mining industry is controlled by a relatively limited number of mostly transnational mining companies. In total, some 150 companies control about 85% of the total, global industrial mine production. Another 900 companies account for the remainder. At the bottom of the pyramid, there are between 4–6 000 junior companies, companies that only explore for metals and do not have a cash flow... These companies could be characterised as the high-tech end of the mining industry. They are small, make rapid decisions and are risk willing, and often make use of new geological models and exploration techniques. If they are successful their share price can increase by many hundreds of per cent, while if they fail they simply disappear."

On this theme Frost (1980, as cited by Kennedy, 1996, p.20) notes, "…ore deposits are discovered by imaginative and innovative people….Large complex organisations are not ideally structured to provide a climate that nourishes innovation." An exemplar of the potential wealth creation such innovative NRCs can produce is evidenced by Fortescue Metals Group. Fortescue Metals Group identified vast new iron resources in the Pilbara region of Western Australia through the successful application of pioneering exploration models. This point is emphasised by Andrew Forrest (2004, p.2), the individual to whom the success of Fortescue Metals Group is generally credited:

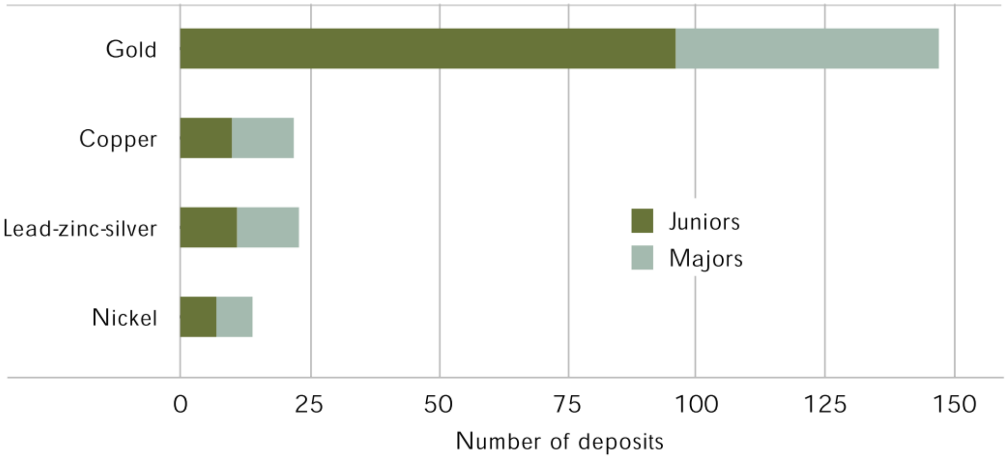
> "Our successful exploration program has been designed around innovative models for iron ore geology which we believe are reshaping industry thinking. Conventional wisdom for 40 years has been that economic deposits of iron ore in the Pilbara follow topographical features. Fortescue Metals challenged that thinking and identified vast areas of iron ore mineralisation under shallow cover and at significant distances from the surface iron outcropping leads. A significant proportion of these discoveries are of high quality ore able to be mined and shipped directly to customers with little or no treatment."

As previously noted, Fortescue Metals Group is a prominent success story; at the time of the above quote, Fortescue Metals Group's market capitalisation was under AU$10 million, whereas, at the time of this thesis, the valuation is in excess of AU$10 billion. Fortescue Metals Group is now the *third force,* in direct competition with BHP Billiton and Rio Tinto, in supplying iron ore from the Pilbara to the steel markets of Asia. The example of Fortescue Metals Group demonstrates the awesome wealth-creation potential of innovative NRCs.

Indeed, there is empirical evidence to support the notion that the NRS may hold competitive advantages in discovering resources vis-à-vis their larger counterparts. For instance, since the 1960s junior explorers have been responsible for approximately 60%

of new discoveries, rediscoveries and renewals in Australia (Geoscience Australia cited by Hogan et al., 2002). The success of junior explorers versus the majors in the Australian context by commodity-type is illustrated in Figure 8.

Figure 8 - Australian mineral discoveries, rediscoveries and renewals



Source: Geoscience Australia, as cited by Hogan et al. (2002)

Such findings broadly align with the conclusions of Maponga and Maxwell (2000) that, from 1970-1997, junior explorers were responsible for 51 percent of Australian copper and gold discoveries. Accounting for the vast advantages the major resource houses hold over NRCs, in terms of human capital and financial capacity, the weight of discovery success attributable to NRCs is especially remarkable.

Nevertheless, the research also suggests that while juniors are adept explorers, the major resource houses have been more successful at discovering the largest resources and, as a result, have captured most of the NPV to derive from the exploration process. For instance, (Parry, 2001) found that the majors had been more successfully in discovering resources with an in situ value greater than $US1 billion. Similarly, Schodde (2004) investigated gold discoveries in the Western world from 1985–2003 and found that while juniors were better at discovering small to medium sized gold resources, majors were better at discovering large gold resources. Consequently, it appears that while the NRS are successful explorers, the major resource houses still hold advantages in discovering the larger quantum resources.

The evidence suggesting that the major resource houses are better at discovering mega-resources is understandable because major resource houses, in tailoring their exploration programs, will only seek resources that can materially add to their earnings base and are thus, by necessity, mega resources. Smaller resources, while economic in and of themselves, cannot meaningfully impact the already large earnings base of major resource houses. Accordingly, major resources houses tend to avoid smaller resources, on the basis that the relatively limited economic benefit the development of such resources contribute to aggregate earnings is, on balance, outweighed by the diversionary aspects mine development inevitably entails. By contrast a NRC will, in addition to seeking large resources, target small to medium resources. This is because the successful development of a small or medium resource would, as a rule, be exceedingly lucrative for a NRC, because any positive earnings represent a dramatic step change for a Company with little or no earnings. In fact, the successful development of any resource would probably be a watershed for most NRCs, as it would signify that the company had achieved the status of miner with earnings. Therefore, the NRS (as well as making important contributions to the global discovery rate) also, develops resources that would otherwise never be developed, owing to the marginal economics of those resources.

2.5.3 The Contribution to Larger Natural Resource Houses

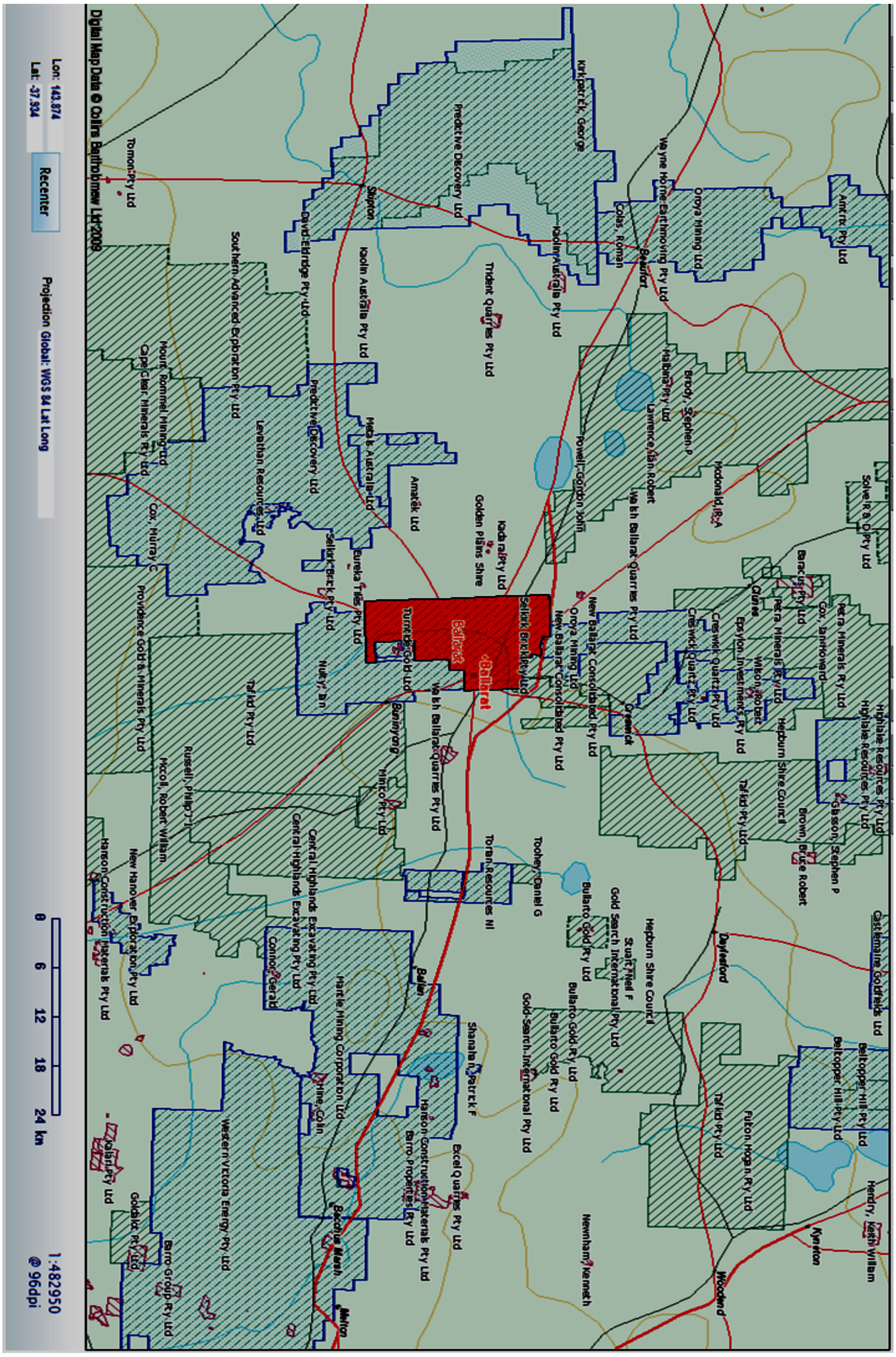
The NRS also supports those larger natural resource houses with market valuations in excess of US$1.5 billion. The work of Iddon, Wright and Hettihewa (2014) is relevant here in its consideration of two key issues: (1) why NRCs proliferate in certain nations, such as Australia and Canada, relative to others, and (2) why the advantages held by larger resource houses (including economics of scale, superior stocks of financial and human capital, and the ability to subsidise exploration expenditure against operating revenues under tax law) don't effectively crowd-out NRCs. The authors conclude that NRCs exist in symbiosis with larger resource houses: NRCs undertake highly uncertain business endeavours and transform such uncertainty into calculable risks that larger resource houses can selectively purchase. For example, NRCs dominant green-fields exploration – a business activity that, in aggregate, is a loss-making activity, but an activity in which a small minority of NRCs will achieve spectacular success - successes that the large resource houses can acquire. While these acquisitions will be at large premiums, given that the NRC has proven their value, in aggregate the larger resources houses enjoy lower cost structures and, thus, higher profitability because they do not have to bear the huge costs involved in resolving the uncertainties that besets the industry.

Consequently, the larger resource houses tend to *outsource* the resolution of uncertainty to the NRS. Thereby, the NRS, a venture-capital focussed industry, confronts and resolves uncertainty in the natural resources sector into calculable risks; while the established resource houses manage and diversify those calculable risks. Some of the uncertainties that the NRS helps resolve concerns the dangers of environmental or social ignominy, by (for instance) exploring in environmentally sensitive areas, or areas of special import to local traditional peoples. Consequently, in cultures that place a high value on corporate social responsibility (like Australia and Canada), the benefits that NRCs bestow on larger resource houses will be especially great and, thus, such cultures are expected, in particular, to support and foster a vibrant NRS (Iddon et al., 2014).

The presence of the NRS is also beneficial to larger resource houses as it ensures that they remain competitive. An example of the dynamic competition pressures the NRS can bring to bear on the larger resource houses occurred in August, 2005 when Rio Tinto Limited's tenure over an iron deposit located in Western Pilbara of Western Australia, known as Shovelanna, expired due to an administrative laxity. On the following Monday, a relatively unknown NRC, Cazaly Resources, took advantage of the oversight and pegged the tenement securing rights to the resource. Cazaly Resources then entered a joint venture with BHP, whereby Cazaly Resources would deliver iron ore from Shovelanna to BHP who operated an adjacent iron ore mine. Although legally Cazaly Resources had secured first rights to Shovelanna, Rio Tinto appealed to Western Australia's resource minister, who decided to employ his ministerial powers to supersede Cazaly Resources and return rights to Rio Tinto. In the subsequent legal contest BHP opted not to support Cazaly, although another iron ore major, who itself had only recently emerged from the obscurity of the NRS to join the Pilbara iron ore majors, Fortescue Metals Group, did support Cazaly. Ultimately, Cazaly was not successful in its bid to secure Shovelanna, but the NRC's actions did serve as a catalyst for Rio Tinto to rectify its tenement management processes (Barrett, 2012). Thus the NRS has the effect of making the resource sector generally more competitive and efficient.

Indeed, the resource industry is at one level analogous to a highly competitive game in which companies seek to identify and secure undervalued exploration and resource projects across the globe. The outcome of the competitive process, an industry jostling to secure undervalued economic ore-bodies and exploration ground, is depicted in Figure 9 for the case of Ballarat and surrounds, a region of Australia famed for its gold.

Figure 9 - Tenements surrounding the gold mining centre of Ballarat



Source: Intierra (2011)

Figure 9 illustrates the virtual chessboard of project tenements held by competing companies across the Ballarat region, a situation generally mirrored for every known region of the planet known to host substantial natural resources.

2.5.4 Section Summary

This section has established the importance of the NRS and, by implication, this research. In particular, the NRS is foundational to the larger resource sector which, in turn, is foundational to the global economy. Additionally, the NRS makes a significant contribution to new discoveries and also develops marginal resources that the larger natural resource houses would never develop. The activities of the NRS also help to ensure that the larger natural resource houses do not succumb to complacency but remain efficient and competitive. Finally, the NRS offers larger natural resource houses the opportunity to outsource ventures involving high levels of uncertainty (including social and environmental uncertainty).

2.6 Chapter Summary

This Chapter has defined the subject matter focussing this research: the NRS. Furthermore, the distinctive nature of the NRS has been established. Also considered were valuation methodologies developed to, albeit imperfectly, cater for the NRS's distinctive nature. Lastly, the Chapter reflected upon the importance of the NRS to the wider economy. In totality, this Chapter has provided the necessary background for the body of this work: identifying and empirically analysing PVFs in the NRS. The following Chapter begins this work by reviewing the literature and empirically verifying the value-relevance of accounting-based PVFs.

Chapter 3: Accounting Factors

3.1 Chapter Introduction

This chapter investigates accounting-based PVFs within the NRS. Firstly, the literature is reviewed to identify accounting-based PVFs. The PVFs so-identified are then empirically examined to determine their significance in practice.

3.2 Accounting-based PVFs

There is a rich extant body of research vouching for the value-relevance of accounting information, especially in the fundamental-analysis tradition. The fundamental analysis tradition is primarily based on the value-relevance of accounting information. Beginning with the pioneering work of Ball and Brown (1968) and Beaver (1968), the value-relevance of accounting information has been extensively studied by the academic community. Excellent reviews of the literature include Bauman (1996), Kothari (2001) and, more recently, Richardson et al. (2010). Accordingly, for this research, the value-relevance of accounting information to the NRS is a natural place from which to embark.

Nonetheless, the extant fundamental analysis literature, which specifically targets the NRS, is limited. Moreover, much of the available research casts doubt upon the value-relevance of accounting information to the NRS. In particular, the value-relevance of accounting information for NRCs at an early stage-of-development, focussed upon exploration and the development of emergent resources, is deemed especially dubious. In this vein, Lonergan (2006) emphasises that balance sheet liabilities and assets, such as exploration acreage, are based upon historical cost and are therefore not reflective of underlying market value. Kennedy reinforces this argument (1996, p.4), “The financial reports of companies often report costs, although successful exploration results in massive differences between costs and values.” Thus, a superficial reliance upon accounting metrics can be misleading. Consider, for instance, the NRS’s common practice of capitalising exploration expenditure, thereby inflating balance sheet asset values. The future benefit of such exploration expenditures is notoriously indistinct and, as might be expected, often results in sudden future write-offs (Rudenno, 2004). Moreover, valuing exploration-focussed NRCs clearly entails the valuation of exploration tenure - but the task of fairly reflecting the value of exploration tenure, including on balance sheets, affords no simple solutions; any attempt to mark-to-market would almost invariably contravene the principle of reliability under Generally Accepted Accounting Principles

(GAAP). Given the ultra-uncertainties involved in resource development, the difficulties of marking-to-market also extend to NRCs developing resources towards production. Further undermining the utility of accounting information for valuation purposes is the reality that most NRCs are venture-capital concerns, devoid of earnings, and for whom future earnings cannot be reliably projected. Without present or future estimable earnings traditional valuation metrics are rendered inapplicable.

Even when a NRC has advanced a resource project to the point of production, accounting statements, reflecting an emphasis on historical, rather than forecasted, earnings, impede utility insofar as valuations are concerned. The inadequacies of accounting information, applied to NRCs operating mines, is also exacerbated by sector-specific features including finite mine lives and often manic commodity prices. Nevertheless, for that small subset of the NRS with active mines, and hence earnings, accounting information is expected to be, at least to some extent, of value-relevance. For example, in an empirical examination of gold miners' decisions to open or close mines by Moel and Tufano (2002), operating costs were found to be a significant factor. Thus, for any given NRC, the value-relevance of accounting information is considered to be, at least in part, a function of that NRC's stage-of-development. Considering stage-of-development, accounting information is expected to be of particular relevance for active miners with earnings. The hypothetical cash flow model presented in Table 3 reflects the key generic accounting information issued by an active miner:

Table 3 - Hypothetical cash flow model

Line	Calculation
1) Capital cost ($m)	Estimate
2) Ore mined (kt)	Estimate
3) Ore milled (kt)	Estimate
4) Commodity produced (kt)	Estimate
5) Commodity price (US$/t)	Estimate
6) Exchange rate (US$: AU$)	Estimate
7) Realised metal price (AU$/t)	5 ÷ 6
8) Revenue ($m)	4 × 7
9) Mining cost ($/t)	Estimate
10) Milling cost ($/t)	Estimate
11) Total operating cost ($m)	2 × 9 + 3 × 10
12) Depreciation ($m)	Depreciation of capital costs (line 1)
13) Pre-tax income ($m)	8 - 11 – 12
14) Tax ($m)	13 × 0.30
15) Net Profit ($m)	8 - 11 – 14

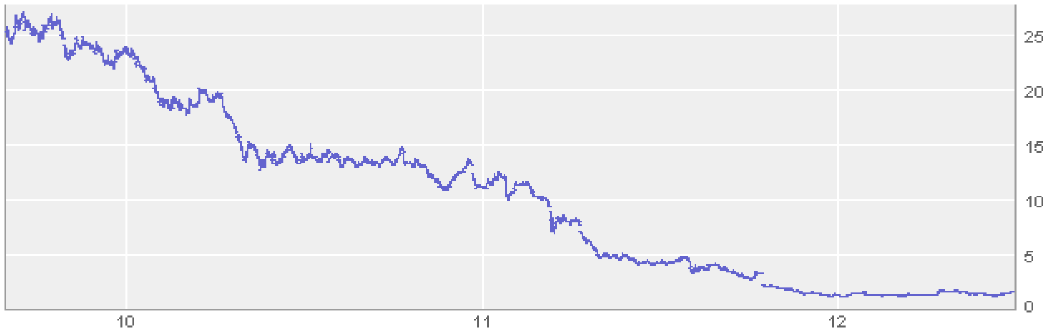
Adapted from Rudenno (2010)

For valuation purposes, item 15, net profit, is the preeminent PVF, as it is the distillation of all the information in Table 3 which precedes it. The special import attributed to net profit is relatively self-evident, cash flow being the foundation of mainstay valuation. As such, the more interesting question becomes: what items in Table 3, and combinations, thereof, are supportive of higher valuations, when net profit is only modest or negative? One possible answer is when net profit is subdued due to low revenues while the NRC in question is producing large amounts of mined output (item 4). In these circumstances, the low revenues are a product of low commodity prices or an unfavourable exchange rate – or some combination of both. NRCs labouring under these difficult conditions might be expected to still enjoy relatively high market valuations, despite restrained net profits, as any positive appreciation in the commodity price, or any depreciation in the currency, will translate into a dramatic improvement in revenues and thus net profits. Still, NRCs may elect to curtail or halt production during times of depressed commodity prices or heightened exchange rates. Another possible answer is when low or negative cash flow is due to relatively high operating costs. In these cases, there is the possibility that concerted efforts on the part of the NRC might reduce the high operating costs and so result in higher net profits. The former suggested answer refers to possible exogenous events that may, through a providential adjustment, result in a cash flow boon for the NRC, whereas the latter suggested answer refers to possible endogenous events, arising from within the NRC, which may likewise result in a positive cash flow step change for the NRC.

Still, in simple terms, net profits is the principal PVF identified for those NRCs operating mines. As such, higher revenues, lower operating costs, higher depreciation write-offs and lower tax rates will, ceteris paribus, be associated with higher market valuations, as these variables are conducive of higher net profits.

Nevertheless, the unique status of the NRS renders valuations based solely on net profits treacherous. Specifically, resources have a finite mine-life and so, net profits derived from the mining process, even after demonstrating excellent reliability and growth over an extended period, may suddenly cease, with little warning from a strictly historical perspective. Indeed, such an occurrence is inevitable, unless the NRC continues to build an inventory of minable resources through successful exploration or acquisitions. Consequently, finite mine life implies that the price/earnings ratio, and related financial ratios such as price/cash flow and price/dividend, employed ubiquitously in other sectors, are of only limited utility to the NRS, as any two mining NRCs most probably have differing mine life profiles (van Eeden, 2006a). A case in point suggesting the importance of mine-life is provided by Figure 10 - which depicts the dramatic reduction in market value for Energy Resources of Australia Limited's from Aug/09 to Aug/12. This devaluation reflects, amongst other factors, the market's concern over for Energy Resources of Australia Limited's declining mineable resources during the period.

Figure 10 - Share price of Energy Resources of Australia Limited



Source: ETRADE Australian Securities Ltd (2012)

The value-relevance of accounting information for a given NRC, as already noted, is largely a function of that NRC's stage-of-development, with the value-relevance of accounting information for NRCs operating mines generally considered significant. At the other end of the spectrum are exploration-focussed NRCs for whom, generally, the value-relevance of accounting information is considered dubious. As previously noted, accounting information, applied to the valuation of exploration-focussed NRCs, is often viewed with severe circumspection because, without productive mines, these NRCs have no earnings to report. Indeed, research by Hogan et al. (2002) could find no relationship between net profit and market capitalisation within the NRS. Such a finding is understandable given that Hogan et al. (2002) sampled NRCs with market capitalisations less than $A200 million - effectively removing NRCs operating mines and reaping consequential business profits from their sample for whom a positive relationship between market capitalisation and net profit would be expected. The value-relevance of accounting information to exploration-focussed NRCs is also undermined due to the glaring disconnect, already alluded to, between the market value of exploration assets and the reported book value of those same assets (Lonergan, 2006; Kennedy, 1996).

Furthermore, many researchers warn that the value-relevance of accounting information is compromised for companies with only limited operational histories. In particular, accounting variables are not considered particularly reliable or useful for young firms whose operations are yet to transition from the extreme precariousness characteristic of their early life (Sine, Mitsuhashi & Kirsch, 2006; Van de Ven, 1984). This is troublesome, given that the NRS is dominated by exploration-focussed NRCs, many of whom only recently listed in the wake of the commodity super cycle. That the value-relevance of accounting information is often dismissed, insofar as exploration-focussed NRCs are concerned, is regrettable; accounting information being the touchstone of fundamental analysis, a major source of PVFs is therefore commonly dismissed. Moreover, given that the NRS comprises, in the main, exploration-focussed NRCs, the dismissal of accounting information insofar as such companies are concerned, effectively precludes the general use of accounting information for valuation purposes from the NRS.

Therefore, it is encouraging that there is countervailing evidence supporting the value-relevance of certain accounting information for exploration-focussed NRC. For instance, the work of Iddon, Wright and Hettihewa (2015) a significant relationship between net assets and market values for exploration focussed NRCs. This result is supported, for the related oil and gas industry, by Ghicas and Pastena (1989), who found that book-value was positively related to market value. Such findings are noteworthy because, as noted, many have questioned the value-relevance of assets and liabilities as recorded on balance sheets in the case of exploration-focussed NRCs. That net assets, which equates to the difference between book-value assets and liabilities, is potentially related to market value suggests that accounting information may in fact be of value-relevance for exploration-focussed NRCs.

One accounting metric of potential value-relevance for exploration-focussed NRCs, supported in the literature, is exploration expenditure. Hogan et al. (2002) investigated the linkage between market capitalisation and exploration expenditures for 105 NRCs from 1999-2000. For this sample, Hogan et al. (2002) reported a weak positive correlation of 0.4 between market capitalisation and exploration expenditures. Substituting for the lack of resource-industry specific analysis examining the relationship between market value and exploration expenditures, analogous research into R&D expenditures is invoked. As previously noted, R&D expenditures may be likened to exploration expenditures – in both cases a firm must commit to considerable expenditures over an extended timeline for a highly uncertain reward. The literature investigating R&D expenditures does support a contemporaneous link between R&D expenditures and present market value (Chauvin & Hirschey, 1993; Toivanen & Stoneman, 2002; Hirschey

& Richardson, 2004). This positive association might be because R&D expenditures signal a potential pipeline of future patents and commercial applications, which the market rewards through higher valuations (Griliches, 1990; Hirschey and Richardson, 2004). Assuming that the analogy drawing together R&D expenditures and exploration expenditures is valid, increased exploration expenditures might, in similar fashion, signal the potential for future economic discoveries, which the market might recognise through higher valuations. Still, the foregoing evidence does not indicate the direction of causation, while higher exploration expenditures might prompt the market to award a higher market valuation, equally, higher market valuations may arise first, and allow NRCs to expend more on exploration. Regardless, exploration expenditure is a recognised PVF under this research.

Also bulwarking the potential utility of accounting information to exploration-focussed NRCs, is the work of Wiklund, Baker and Shepherd (2010). Wiklund et al. (2010) has provided compelling evidence that accounting information may, contrary to the general consensus, be especially value-relevant for companies during their earliest stages-of-development. In particular, Wiklund et al. (2010) having surveyed 30,000 firms over their first seven years of life, found that higher levels of liquidity (defined as working capital divided by total assets), lower leverage (defined as total liabilities divided by total assets) and higher profitability (defined as net income divided by total assets) are all associated with a greater chance of firm survival. As such, Wiklund et al. (2010) conceptualised these accounting metrics as *buffers*, – contending that healthy profits, liquidity and low leverage provide fortification against the myriad of fatal threats endangering companies in their nascent phases of life. Moreover, Wiklund et al. (2010) found that the buffering effect engendered by these accounting metrics is proportional to the age of the firm: the younger the firm the more significant the buffering effect was found to be. While the importance of profits has already been considered for those NRCs operating mines, liquidity and leverage represent alternative accounting-based PVFs that are not restricted to the small minority of NRCs operating mines.

Within the NRS, the import of liquidity is often signified by current cash holdings and the rate at which these cash holdings are being depleted. Indeed, *cash burn* is a common preoccupation throughout venture-capital, given the limited capital with which these firms have to create business traction while averting the real risk of bankruptcy (Drummond, 2001). (Acharya, Almeida, & Campello, 2007) argue that cash reserves are especially important for firms with high hedging requirements – that is, firms for whom there is a poor relation between cash flow and investment opportunities. Thus, for the NRS, a sector generally devoid of earnings, seeking to capitalise on investment opportunities in the resources space, cash reserves are likely to be held in high esteem. Indeed, there is evidence that market value is related to discretionary cash flow in the related oil and gas industries, presumably because discretionary cash flow allows firms to undertake additional exploration (Johnston, 1992). Thus, it is sensible that market values reflect a NRC's working capital, not only because ample cash reserves help fortify a company from insolvency, as Wiklund et al. (2010) emphasises, but also because cash reserves are required for a NRC to advance its exploration and resource development programs - essential business endeavours if the NRC is to create real value.

Cash holdings are considered very important for financially constrained firms—i.e. firms for whom the cost of external finance is high and who, consequently, favour internal finance; be that sourced from earnings or cash reserves (Denis & Sibilkov, 2009). Under this definition, NRCs are habitually financially constrained. Research typically indicates that, in financially constrained firms, higher cash reserves are associated with increased investment and higher market values (Denis & Sibilkov, 2009; Faulkender & Wang 2006 and Pinkowitz & Williamson, 2004). Explicitly focussed upon the resource sector, Rudenno (2010), also, supports the value-relevance of cash (and other liquid investments) as a key indicator of market value. Empirical research by Iddon et al. (2015) also supports the value-relevance of working capital within the NRS. Moreover, in an essentially capitalist process, investors in the NRS will allocate their limited capital to those NRCs they consider to hold the most promise. Therefore, insofar as investors are accurate in this capital allocation process, higher cash balances may be indicative of those NRCs with greater promise who consequently enjoy higher market values.

Another accounting PVF in the NRS is debt. Gallery and Nelson (2008) note that approximately one third of NRCs hold debt on their balance sheets, although the majority of these are at a more advanced stage-of-development. Given the high capital requirements involved in developing a resource to mineable status, virtually all mining projects are brought on-stream with the aid of debt funding. Still, for natural resource developments, a high proportion of equity to debt is generally required to satiate the conservative risk requirements of debt financiers. For instance, Gaol and Anggono (2011), in an analysis of Indonesian coal companies, estimated the optimal capital structure as ranging between 0-20 percent debt or, equivalently, 80-100 percent equity. Benning (2000, p.147) reports more general figures for the resource industry, “the majority of projects will have a debt:equity ratio in the range of 30:70 to 60:40.” The high proportion of equity to debt is generally a necessary precursor, because the contribution of equity effectively represents the market’s substantiation of a NRC’s proposed development. Notably, the benefit accruing to equity holders is not capped on the upside, so equity can assume greater risks, whereas, the potential upside for debt is capped; consequently, debt generally avoids high risk. Hence, if equity chooses to shy away from a proposed natural resource project, presumably, the uncertainties are too great or the hope of reward too small to admit the substantive margin of safety that would be demanded by debt. Thus, without the initial substantiation from equity of a project’s merits, debt financing will be exceedingly difficult if not impossible to obtain. When a NRC does secure debt for a natural resource development there are generally additional obligations designed to protect the interests of debt providers. These obligations include a debt service reserve account: a separate reserve of cash sufficient to meet short-term principal and interest payments (Rudenno, 2004).

Hence, virtually all NRCs on the threshold of production will hold debt on their balance sheet. In these cases, debt will generally be associated with high market valuations, given that the NRC is on the verge of production. According to Benning (2000) debt provides two principal advantages: (1) it frees cash for alternative uses and, (2) it provides leverage to equity holders and thus, greater returns if the project proves a success. Therefore, while debt is positively related to market value, the direction of this relationship is likely conditional upon stage-of-development. In particular, for those firms who have incurred high debt levels, and yet, remain mired in an embryonic stage-of-development, debt is probably negatively related to market value. Indeed, as already noted, Wiklund et al. (2010) have found that for nascent firms, high debt levels are associated with an increased probability of insolvency.

Still, as previously discussed, even for those NRCs on the threshold of production or in early production, there are heightened risks associated with high debt levels. In particular, problems inevitably arise as production commences which can pressurise NRCs when debt levels are at their peak. An important question which follows is thus: what accounting information does the market employ to discount those NRCs, near or recently commencing production, who are likely to encounter problems? One promising candidate is the debt/equity ratio. High debt/equity values have been linked to an increased chance of bankruptcy in the wider literature (Hambrick, 1988). Furthermore, for NRCs in the early years of production, high debt-to-equity may signal that earnings have been below forecast imperilling the project's viability. On the other hand, high debt-to-equity levels will provide excellent leverage to success for equity in the event of success, and this may be reflected in higher market values. Equally, for those NRCs on the threshold of production, a high debt-to-equity ratio may reflect that a project is particularly robust – equity holders only had to contribute a modest amount in order to attract debt financing. Either way, the debt-to-equity ratio is recognised as a PVF herein.

As discussed, according to many authorities, the distinctive nature of the NRS renders reliance upon the value-relevance of accounting information, especially in the case of exploration-focussed NRCs, hazardous. On the other hand, some authorities suggest that accounting information is of value-relevance to the NRS – including for exploration-focussed NRCs. In reconciling these two perspectives it might be concluded that, accounting information, while hosting PVFs, is best augmented with other non-accounting PVFs. Such a conclusion is broadly supported by the wider literature. For instance, Amir and Lev (1996), investigating the wireless communications industry, found that while accounting information possessed only poor value-relevance compared to non-accounting information, accounting information, when combined with non-accounting information, did complement and support an explanation of market value. This study is pertinent as the wireless communications industry bears important parallels with the NRS, in particular, habitual negative cash flows. Such a finding is supported by Quirin et al. (2000), who investigated the oil and gas industry, another sector related to the NRS. Quirin et al. (2000) sourced PVFs through a survey of oil and gas analysts and concluded that the analyst's PVFs, which wedded both accounting and non-accounting factors, granted marginal explanatory power over traditional accounting measures in terms of both an enterprise's stock value and future stock returns. Furthermore, from a theoretical standpoint, the importance of considering non-accounting PVFs is expected to be especially significant for the NRS due to the fundamentally multidisciplinary nature of the sector, to this end Frimpong (1992, p.2) notes:

> "Mineral project evaluation is interdisciplinary in nature…it requires experts from many fields, such as geology, mining, engineering, mineral processing, economics, finance, environmental, and regulatory departments. The decision-making involved combines the vision of the developer, the organising talent of the manager, the analytical ability of the economist, and the technical capability of the engineer, together with the mathematics of finance."

Hence, the literature suggests the approach adopted under this study: embracing both accounting and non-accounting variables as potential sources of value-relevance.

3.3 Data, Data Processing and Statistical Analyses

The objective of this section is to empirically examine accounting-based PVFs within the NRS. The primary data employed in this chapter was sourced from Intierra (2011) in Dec/11 and comprised all listed companies from across the globe with a market capitalisation below US$1.5 billion and involved in the NRS at that time. This represented 3,045 unique companies. For these companies, numerous accounting variables were available from 2008-11 inclusive. Non-accounting variables were also available as cross-sectional data as of Dec/11. Examples of these non-accounting cross-sectional variables include the primary stock exchange on which the company was listed and its stage-of-development (for instance, an explorer or producer).

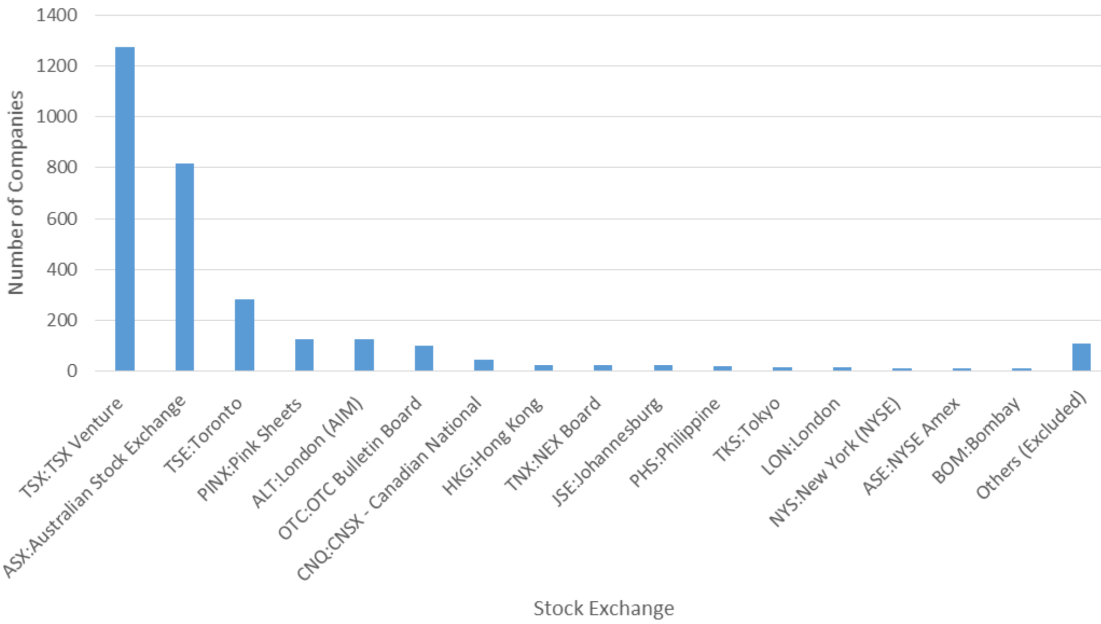
To reaffirm: the objective of this chapter is to test the value-relevance of accounting-based PVFs. Given that the accounting variables in the dataset are observed through time panel data analysis is employed to achieve this objective. Generally, accounting information is released with equidistant periodicity through the medium of accounting statements. Thus, accounting information is especially amenable to panel data analysis because an underlying assumption of panel data analysis is that the variables are observed at equally spaced intervals through time.

Andress, Golsch and Schmidt (2013, p.16) conceptualise panel data as a three-dimensional “cube” comprising the units (in our case companies), the time periods (in our case the four years 2008 through 2011) and the variables (in our case the accounting-based and other PVFs). A defining feature of panel data is that the *same* units are observed through time. This feature gives rise to one of the primary advantages of panel data analysis: the capacity to control for permanent yet unobserved heterogeneity across units. By accounting for this type of unobserved heterogeneity a degree of omitted variable bias is overcome that otherwise could not be controlled for. Another advantage of panel data analysis is the potential to come closer to testing for causality than simple cross-sectional analysis can allow. However, these advantages are counterbalanced by, amongst other factors, an added degree of complexity (Andress et al., 2013). Nonetheless, this chapter employs panel data analysis to help elucidate accounting-based PVFs in the NRS.

3.3.1 Refining the NRS

As noted, the dataset comprises 3,045 companies involved in the natural resource sector with market capitalisations below US$1.5 billion for whom accounting variables are observed from 2008 to 2011.[16] These 3,045 companies are listed on 56 different stock exchanges from around the globe. Nonetheless, most companies are concentrated in a relatively small subset of these 56 stock exchanges, particularly on two Canadian exchanges, the TSX and TSE, as well as Australia's ASX. Accordingly, to simplify the analysis, exchanges housing less than 10 companies involved in the NRS were excluded. Given that a handful of stock exchanges house most companies involved in the NRS, this exclusion dramatically reduced the total number of stock exchanges in the analysis– from 56 exchanges to just 16 exchanges (this is, approximately 71 percent of exchanges were dropped) – with only a minor impact on the total number of companies involved in the NRS – from 3,045 companies to 2,935 companies (that is, approximately 3.6 percent of companies were dropped). Figure 11 illustrates the number of resource companies in each of the 16 stock exchanges included in this analysis, in addition to the number of companies in the aggregated 40 stock exchanges excluded from the analysis.

Figure 11 - Distribution of resource companies across global stock exchanges



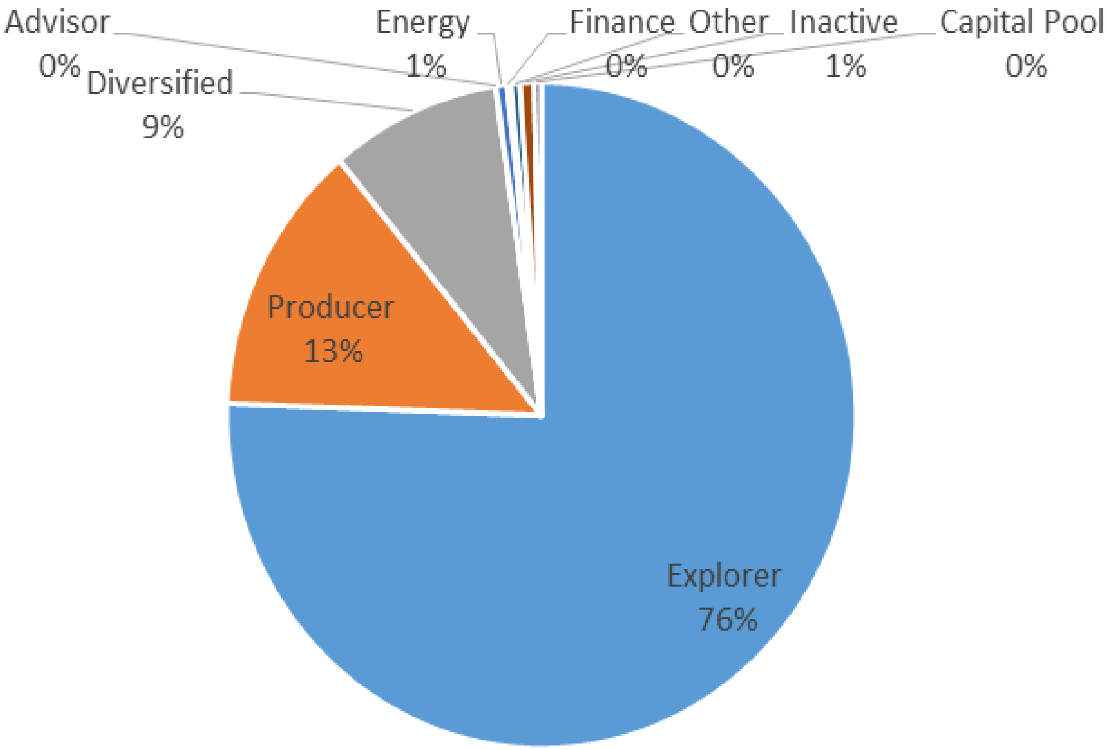
Derived from Intierra (2011) data

The dataset was further paired back to more explicitly focus on the NRS as defined under this study. In particular, the cross-sectional component of the dataset

[16] Notably, there is survivorship bias in this dataset, with companies going private or entering insolvency in the four years before December 2011 not included in the sample.

classified companies into one of the following types: exploration, producer, advisor, capital pool, diversified, energy, finance, inactive and other. As Figure 12 illustrates, the exploration and producer companies together capture approximately 89% of the sample. Thus, in keeping with the Pareto principle (the 80-20 rule), companies belonging to any type, save than exploration and producer companies, were culled from the sample. This reduced the number of companies from 2,935 to 2,609. By only retaining exploration and production companies the sample represents the NRS as the term is defined under this research.

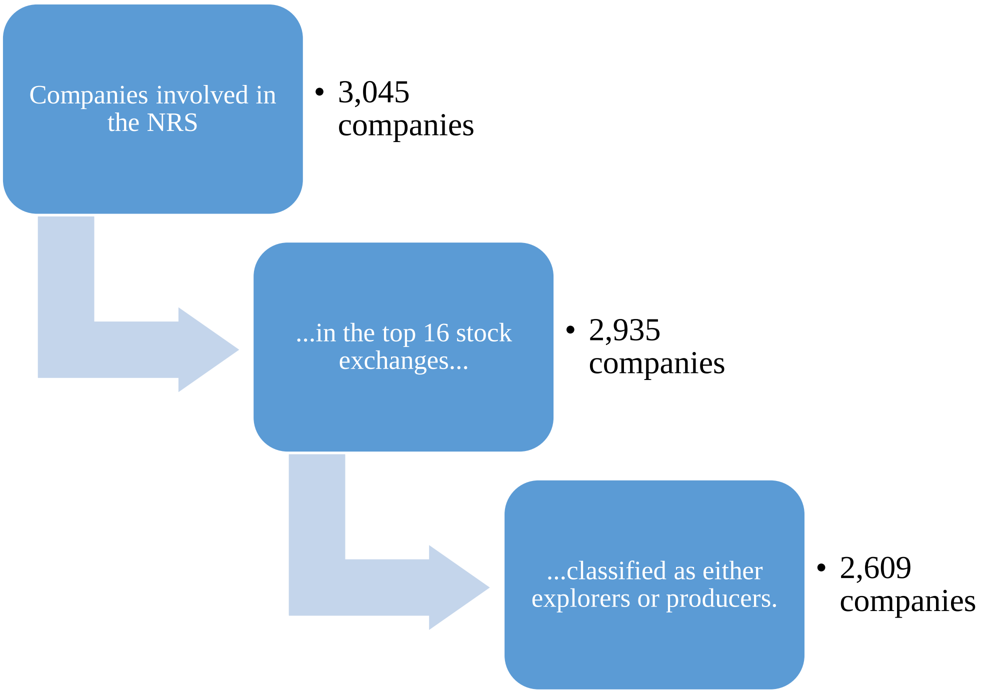
Figure 12 - Resource companies by type



Derived from Intierra (2011) data

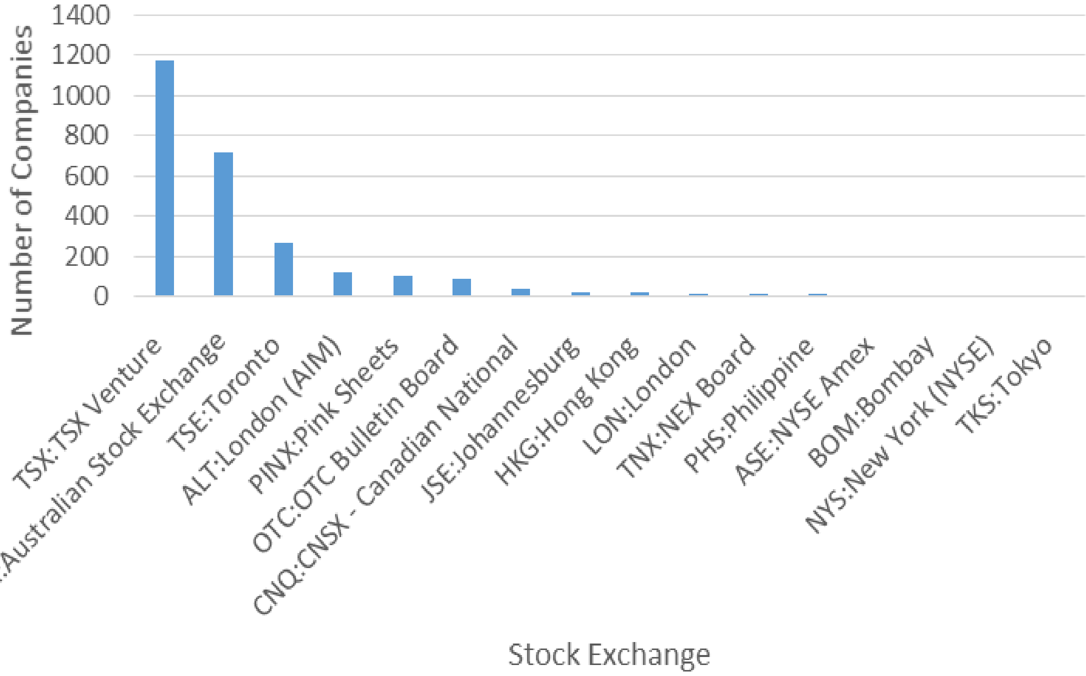
Figure 13 summarises the winnowing process discussed above. Importantly, the remaining 2,609 NRCs form the *master-sample* on which the empirical analyses to follow are based. This includes the following chapter that empirically analyses capital raisings and which are cross-referenced to ensure that each company sampled and conducting a capital raising is one of the 2,609 members of the master-sample. This cross-referencing is performed to ensure that all the companies analysed herein are truly NRCs as defined under this research.

Figure 13 – Identifying the master-sample



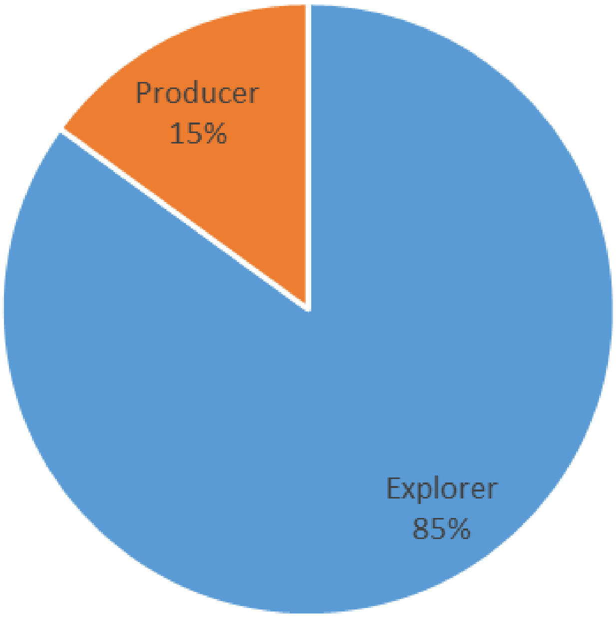
Given the importance of this master-sample, as the effective representation of the NRS, both the stock exchange distribution (see Figure 14) as well as the explorer/producer distribution (see Figure 15) is plotted to help provide some intuition concerning the NRS.

Figure 14 - Distribution of NRCs across global stock exchanges



Based upon data from Intierra (2011)

Figure 15 - NRCs by type



Based upon data from Intierra (2011)

Thus, focussing upon the master-sample of 2,609 NRCs – the effective NRS – this chapter will employ available accounting information, covering the period 2008 to 2011 inclusive, to help determine the value-relevance of accounting information.

Although based on the master-sample of 2,609 NRCs the sample was further reduced for the purposes of this chapter. In particular, all the NRCs in the master-sample held market capitalisations below US$1.5 billion at December 2011. However, this panel data analysis involves the previous four years, in which periods the companies might have possessed higher market capitalisations above the US$1.5 billion cut-off point. To remedy this issue any company with a recorded market capitalisation above $1.5 billion in any of the preceding periods was removed from the sample. This resulted in the exclusion of another 31 companies. In addition, the dataset included a degree of missing data where some or even all of the accounting variables of interest were not observed. In order to remove especially grievous cases of missing data, a filter was applied. The filter examined the four reported market capitalisations and the accounting-based PVFs included in the model and, where any company had five or less observations across these variables it was removed from the sample. This ensured that for any given company there was at least one observation of one accounting variable over the four year period. This filter reduced the sample by 237 companies. Thus, following these additional exclusions, the sample that this chapter employs is based upon a total sample of 2,341 companies.

3.3.2 Accounting PVFs

In the literature review, seven accounting-based PVFs were identified:

(1) Net Profit,
(2) Profitability (i.e. net profit/total assets),
(3) Net Assets (i.e. total assets – total liabilities),
(4) Working Capital (i.e. current assets – current liabilities),
(5) Debt (i.e. total liabilities),
(6) Debt to Equity (i.e. total liabilities/(assets – liabilities)), and
(7) Exploration Expenditure

These accounting-based PVFs are reported annually and, given that the data is drawn from 2008 to 2011 inclusive, the time dimension for this panel data is four years.[17]

The objective of this chapter is to illuminate the relationship between market value and accounting-based PVFs. To this end market capitalisation is taken to be represent market value. Based upon the preceding literature review, the following functional form is proposed to represent the relationship between market capitalisation and accounting-based PVFs.

Market Capitalisation = Net Profit + Profitability + Net Assets + Working Capital + Debt + Debt-to-Equity + Exploration Expenditure

However, this function is still incomplete, and it is left to the next section to remedy this fact.

3.3.3 Omitted Variable Bias

Notably, there are a number of non-accounting PVFs that might contribute to explaining market value and, moreover, be significantly correlated with the accounting-based PVFs identified. More generally, omitted variable bias is only a concern when the omitted variables are significantly correlated with the variables being investigated. Specifically, stage-of-development, stock exchange and macroeconomic conditions are hypothesised to influence market value and also, potentially, be correlated with the accounting-based PVFs. Thus, these non-accounting based PVFs are included in the model, and so the functional form noted above is re-iterated as:

Market Capitalisation = Net Profit + Profitability + Net Assets + Working Capital + Debt + Debt-to-Equity + Exploration Expenditure + Stage-of-Development + Stock Exchange + Macroeconomic Conditions

[17] With the exception of exploration expenditure which is reported quarterly. However, exploration expenditure is annualised (i.e. the summation of four quarters) in order to conform to the other annually quoted accounting PVFs.

Given the importance of these three non-accounting PVFs to the model, stage-of-development, stock exchange and macroeconomic conditions will be considered presently in that order.

The literature review suggested that stage-of-development may moderate the value-relevance of accounting-based PVFs such that accounting-based PVFs would be highly value-relevant for NRCs at an advanced stage-of-development but less so for NRCs at an earlier stage-of-development. Accounting-based PVFs are also expected to correlate with stage-of-development, such that NRCs at a more advanced stage-of-development would generally be expected to have higher levels of net profits, profitability, net assets, working capital, debt, debt-to-equity ratios and exploration expenditures. Equally, stage-of-development is related to market value, and forms the subject of a later chapter. Thus stage-of-development is included in the model.

In addition, there is reason to believe that stock exchange might be related to both market value and accounting-based PVFs. In particular, it is noted that certain stock exchanges do house NRCs with higher market values vis-à-vis other exchanges due, for instance, to varying listing rules mandating different minimum asset and profit benchmarks before a company can list. Also, there is good reason to suspect that stock exchange values might be driven to some degree by accounting-based PVFs. For instance, Smithson and Firer (2007) found that stock exchange influenced the discount rate at which NRCs could secure capital. Differing discount rates between stock exchanges might affect accounting-based PVFs in various ways, influencing, for instance, levels of working capital. Moreover, different stock exchanges, to at least some degree, represent different investor bases, and these varying investor bases may, perhaps due to variable risk tolerances, affix different market values to otherwise identical accounting information.

Similarly, macroeconomic conditions are hypothesised to both influence market value and correlate with accounting-based PVFs. Specifically, positive macroeconomic conditions are held to coincide with buoyant market values while negative macro-economic conditions correspond to depressed market values. Equally, macro-economic conditions are expected to influence accounting-based PVFs. For instance, under positive macro-economic conditions, NRCs may be able to raise capital more easily, which might translate into higher cash and debt levels. Therefore, macro-economic conditions are incorporated into the model.

Two of the three non-accounting PVFs included in the model, stage-of-development and stock exchange, are only available as cross-sectional data. That is, while the accounting-based PVFs are observed over a four year period, stage-of-development and stock exchange are observed as of Dec/11. Thus, by including stage-of-development and stock exchange in the model, some measure of omitted variable bias is overcome but, in introducing these two variables, the assumption is that stage-of-development and stock exchange were constant for the four years preceding Dec/11. Given the mercurial nature of the NRS such an assumption is hazardous. Nonetheless, it is noted that stock exchange, in particular, is a relatively *sticky* variable – it is an extremely rare occurrence for a NRC to take the trouble to change its primary stock exchange.[18] By contrast, stage-of-development is a more fluid variable, especially over a period of four years. Nonetheless, stage-of-development here is measured as a dichotomous variable, being either an explorer or producer and thus, it is still a relatively rare occurrence for a NRC to make the transition to producer status, or, for that matter, for a producer to regress to exploration status. Still, there will be a degree of measurement error over the four year period considered in which explorers will be incorrectly classified as producers and vice versa. Thus, by overcoming a degree of omitted variable bias with the inclusion of stage-of-development and stock exchange into the model, this research has introduced a modicum of measurement error.

For the remaining non-accounting PVF included in the model, macroeconomic conditions, it was decided to create a new financial index that could accurately reflect macroeconomic conditions insofar as the NRS is concerned. The next section outlines the details underlying the construction of this index. Although it is a slight detour given the accounting focus of this chapter, the index is an important inclusion into the model testing for accounting-based PVFs given the previously mentioned issues around omitted-variable-bias. Furthermore, this index is repeatedly drawn upon in latter chapters, so it forms an important element of the work more broadly.

[18] Although it is relatively common for NRCs to, in addition to their “home” stock exchange, list on additional stock exchanges. The usual motivation here is to lower the cost of capital by broadening the potential investor base.

3.3.4 A Macroeconomic Index for the NRS

The primary macroeconomic index influencing the NRS is commodity prices. Commodity prices represent the distillation of demand and supply for commodities across the global economy. Thus, commodity prices capture fluctuations in the incentive for NRCs to discover natural resources and reach production status.

Accordingly, an index of commodity prices is employed to control for the macro-economic backdrop under which the NRS is operating. However, no commodity price index could be located that accurately represents commodity prices as they relate to the NRS. In particular, commodity indexes generally weight the constituent commodities according to global production (or, equivalently, consumption). For example, the weighting of metals employed in the *Rogers International Commodity Index®-Metals* (RICI-M Index) is based upon, "liquidity and weighting in their respective underlying world-wide consumption" (Beeland Management Company, 2014). The weighting of metals in the RICI-M Index that flows from this approach is presented in Table 4. Table 4 reveals, for instance, that aluminium is an important constituent in the index. Nonetheless, considering the NRS, it is noted that very few companies are involved in aluminium. Thus, it can be inferred that absolute global production levels is not the only factor mandating which commodity-types NRCs choose to pursue. For instance, NRCs may also factor such issues as per unit prices, metallurgical complexity, and generic CAP-X before committing to the pursuit or development of a given commodity.

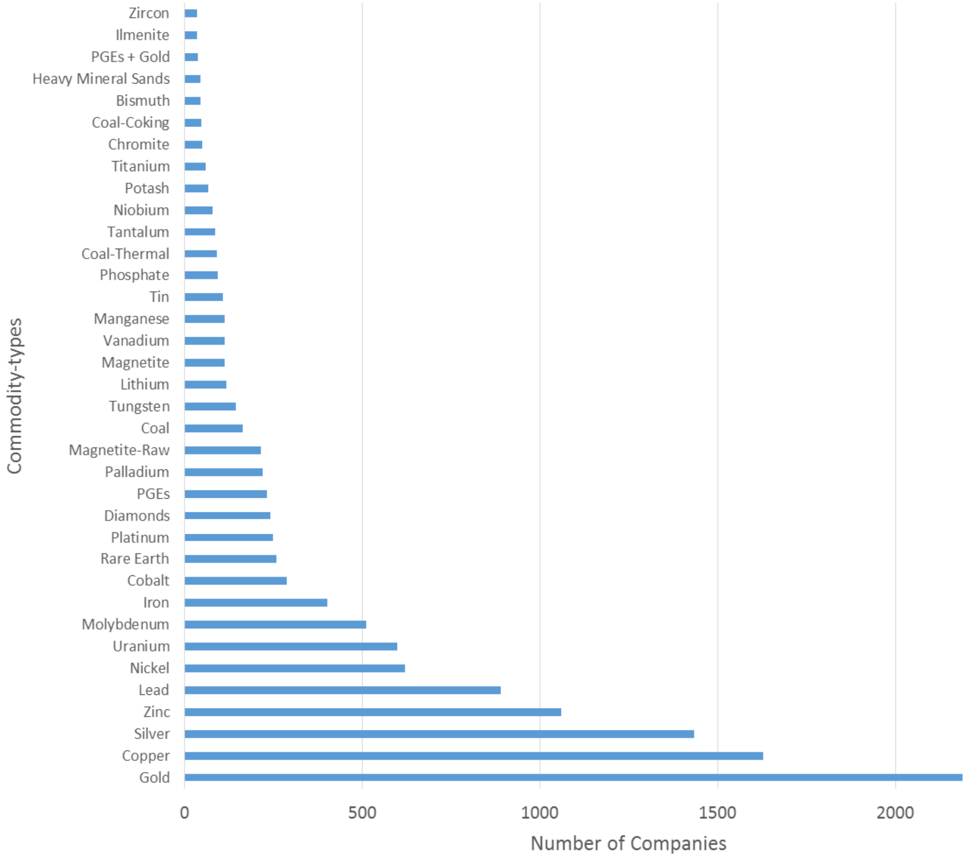
Table 4 - Weighting of metals in the RICI-M Index

Commodity	Allocation
Copper	18.96%
Aluminum	18.96%
Gold	14.22%
Silver	9.48%
Lead	9.48%
Zinc	9.48%
Platinum	8.53%
Nickel	4.74%
Tin	4.74%
Palladium	1.42%
	100.00%

Source: Beeland Management Company (2014)

In order to redress the dearth of commodity indexes specially tailored to reflect the NRS, a new index is created and dubbed the *NRS Commodity Index* (CI_{NRS}). This new index is based upon the master-list 2,609 NRCs. The Intierra dataset includes the underlying projects held by each of these 2,609 NRCs and the commodities that these projects are being pursued for. From this information, the commodities of interest to the NRS can be determined. Firstly, the number of commodity-types was culled to a manageable figure by only including commodity-types for which at least 30 NRCs were involved – that is, the *primary commodity-types*. Subsequently, the number of NRCs involved in each of these primary commodity-type was recorded as per Figure 16.

Figure 16 - Number of NRCs involved in the primary commodity-types



Derived from Intierra (2011) data

Figure 16 reveals the 36 primary commodity-types of interest to the NRS. Moreover, Figure 16 illustrates the number of NRCs involved in each of these commodity-types – that is, the number of NRCs holding projects prospective for that commodity-type. The number of NRCs involved in a commodity-type reflects the relative importance of that commodity-type to the NRS as a whole. Indeed, the commodity-types and their relative weighting is the basis of the CI_{NRS}.

Accordingly, the CI_{NRS} seeks to represent the 36 primary commodity-types in the NRS where the number of NRCs involved in each commodity-type provides the relative weighting afforded to each of the commodity-types. Consequently, the weighting attached to a given commodity-type under the CI_{NRS} equals the proportion of NRCs involved in that commodity-type from the entire NRS. As such, a limitation to the CI_{NRS}'s weighting scheme is that it is static. This limitation is equivalent to the issue of coercing cross-sectional data into a time dimensional model as previously discussed for the other two non-accounting based PVFs (stage-of development and stock exchange). In particular, the weighting scheme is based upon the commodity-types of interest for the NRS as at December 2011. This weighting scheme is then applied retrospectively. However, the dynamic reality of the NRS means that the *true* weighting scheme will be constantly shuffling as the NRS responds to commodity-types coming in and out of vogue. Indeed, the NRS is always changing to better reflect current and projected commodity prices although there is an inevitable lag to this process.

Having sourced the constituent commodity-types and their relative weighting in the CI_{NRS}, the returns for each commodity-types were multiplied by that commodity type's relative weighting and sum the total of these products, through time, produced the CI_{NRS} (i.e. each of the 36 commodity-types, C, represent a proportion of the CI_{NRS}, $P_{C)}$ and commodity-type has returns, over time period t, of R_t. Thus, the CI_{NRS} is:

$$CI_{NRS} = \sum_{C=1}^{36} (P_c * R_t)$$

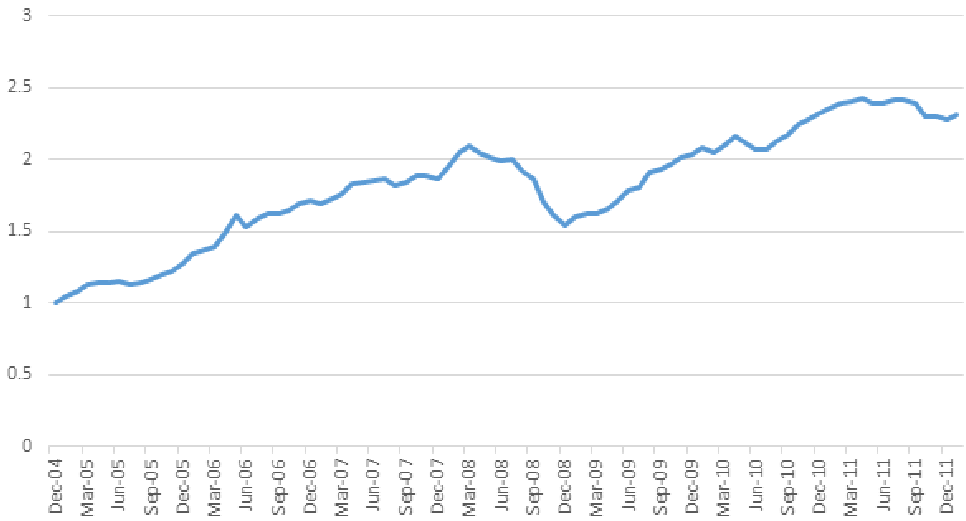
Historical prices for commodity prices were sourced from ABARE (as source via Intierra), Thomson Reuters Tick History, the IMF and the World Bank. Unfortunately, there was a number of commodity-types for which historical prices could not be secured. In many cases, a reasonable proxy of these historical prices was constructed and employed in lieu.[19] Nonetheless, for a number of commodity-types, historical prices could not be obtained and no reasonable proxy was inferred. In particular, historical prices for rare earths, diamonds, lithium, niobium, ilmenite and zircon are neither obtained nor are proxies set. Consequently, these commodity-types were not included in the CI_{NRS}. Despite the exclusion of these six commodity-types, the CI_{NRS} still captures 93.97 percent of NRC involvement in the primary commodity-types.[20]

[19] To represent PGMs the historical returns for platinum, palladium, iridium, rhodium, ruthenium (osmium could not be obtained) were averaged. Similarly, PGEs + Gold was represented by the average of the PGM proxy and gold. For heavy minerals sands, titanium prices were employed as a proxy. The Newcastle coal price is set as a proxy for coal, coal-thermal and coal-coking. The historical price of iron ore is set as a proxy for magnetite-raw and magnetite.

[20] For the 36 primary commodity-types, there are 12,654 NRCs involved in their pursuit. By excluding rare earths, diamonds, lithium, niobium, ilmenite and zircon this figure falls to 11,891. That is, the CI_{NRS} captures 93.97% (=11,891/12,654) of NRC involvement in the primary commodity-types.

The current commodity price super-cycle likely started in 2005 (Battellino, 2010). Thus, the CI_{NRS} is set to begin at December 2004 with the index given an initial value of 1. Figure 17 illustrates the growth in the CI_{NRS} index over the course of the commodity price super-cycle. Consequently, the CINRS is included as a variable in the model.

Figure 17 - Performance of the CI_{NRS}



3.3.5 Endogeneity

In some ways related to the issue of omitted variable bias is that of endogeneity (Andress et al., 2013). The model proposed relates the dependent variable, market value, to the explanatory variables (in particular, the accounting-based PVFs, stage-of-development, stock exchange and macroeconomic conditions). However, a later chapter considers the real potential for endogeneity in the NRS – where market value is determined by such fundamentals as accounting information but also, in reverse, helps determine those same fundamentals. Consequently, if an explanatory variable x causes y positively this effect can be amplified if y also causes x positively – or negated if y causes x positively. Given that panel data is employed herein, a lag/lead model is adopted to help remedy the potential for such endogeneity. This endogeneity issue was resolved by reiterating the model in terms of lags and leads. In particular, the model is reiterated as:

$$\text{Market Capitalisation}_{(t)} = \text{Net Profit}_{(t-1)} + \text{Profitability}_{(t-1)} + \text{Net Assets}_{(t-1)} + \text{Working Capital}_{(t-1)} + \text{Debt}_{(t-1)} + \text{Debt-to-Equity}_{(t-1)} + \text{Exploration Expenditure}_{(t-1)} + \text{Stage-of-Development} + \text{Stock Exchange} + \text{Macroeconomic Conditions}_{(t-1)}$$

Although this model helps remedy the endogeneity issues it reduces by one the time periods captured under the analysis. In particular, the beginning year (2008) was lost from the analysis, thereby shortening the time dimension to three years: 2009 to 2011.

This is a relatively 'short' time dimension (t), and, given that this chapter considers several thousand companies, the unit dimension (n) is clearly more expansive (i.e. n >> t). Such panel data is generally referred to as a 'short panel' (for instance, Croissant and Millo, 2008) and is generally dichotomised against the inverse 'long panel' scenario where the time dimension is more substantive and sometimes even exceeds the number of units ($n<t$) (Andress et al., 2013). The distinction between short and long panels is an important one given that it helps inform statistical analysis. Thus, it is established that this research is concerned with short panel data.

3.3.6 Heterogeneous Fiscal Years

As noted earlier, a special requirement of panel data analysis is that the variables are observed at equally spaced intervals through time. Meeting this requirement is complicated because the NRCs are drawn from stock exchanges situated in different nations who legislate varying fiscal-years. Table 5 details, for each of the 16 stock exchanges under consideration, the nation to which it belongs and the associated fiscal year. A further complication arises because that the majority of these nations, as indicated by asterisks in Table 5, allow companies to establish their own fiscal years.

Table 5 - Fiscal year given stock exchange and nation

Stock Exchange	Nation	Fiscal Year (may vary by firm)
TSX:TSX Venture	Canada	1 January to 31 December*
ASX: Australian Stock Exchange	Australia	1 July and to 30 June
TSE: Toronto	Canada	1 January to 31 December*
PINX: Pink Sheets	United States	1 January to 31 December*
ALT: London (AIM)	United Kingdom	1 April to 31 March*
OTC: OTC Bulletin Board	United States	1 January to 31 December*
CNQ: CNSX - Canadian National	Canada	1 January to 31 December*
HKG: Hong Kong	Hong Kong	1 April to 31 March*
TNX: NEX Board	Canada	1 January to 31 December*
JSE: Johannesburg	South Africa	1 March to 28 or 29 Feb*[21]
PHS: Philippine	Philippines	1 January to 31 December*
TKS: Tokyo	Japan	1 April to 31 March
LON: London	United Kingdom	1 April to 31 March*
NYS: New York (NYSE)	United States	1 January to 31 December*
ASE: NYSE Amex	United States	1 January to 31 December*
BOM: Bombay	India	1 April to 31 March*

[21] This is the general fiscal-year for "newer" companies in South Africa while older companies often end their fiscal-year on June 30 as a legacy from England. Given that NRCs are generally newer enterprises the former date was chosen to represent the fiscal-year.

Thus, the generic fiscal years at the national level do not represent the actual fiscal years of every NRC in the sample. Indeed, manual investigation of the underlying sample revealed a nontrivial portion of NRCs electing idiosyncratic fiscal years. Furthermore, identifying which NRCs operate under idiosyncratic fiscal years is not feasible.

As such, the heterogeneity of fiscal years could not be controlled for in this research. As a result, the usual presumption of panel data analysis that the observed variables are issued contemporaneously and equidistant in time, will be violated. Consequently, the inclusion of companies employing idiosyncratic fiscal years is a form of measurement error and a limitation of this research.

3.3.7 Calculating Market Value

In order to determine the market capitalisation of a given NRC for the relevant 2008 through 2011 fiscal-year end-dates, information on the number of shares and share price data was collected from Thomson Reuters Tick History (2014). To determine market capitalisation for each fiscal-year end-date, the number of shares and share price were multiplied together.

More specifically, the number of shares was taken to be the last reported number of shares from the Thomson Reuters database for the year preceding the relevant fiscal-year end-date. This was necessary as the Thomson Reuters database only records the number of shares on those dates when the number of shares actually changes (e.g. through a new share issue). The share price was determined for the 30 days preceding the relevant fiscal-year end-date, as well as for the 30 days succeeding the relevant fiscal-year end-date and for the actual fiscal-year end-date. This 61 day series (30 +1 + 30) of VWAPs, symmetrically distributed about the fiscal-year end-date, was then averaged to calculate the share price. That is, the share price was effectively a point estimate based upon VWAPs over a multi-month time-frame. The reasoning behind such a *weighted* point estimate was to overcome some of the unique characteristics of the NRS that might otherwise veil attempts to measure true market value, namely: illiquidity and extreme share price volatility. Specifically, illiquidity is a problem because it creates a scarcity of trading data, but, by employing VWAPs the maximum amount of trading data available is drawn upon. Similarly, extreme share price volatility renders a reliance upon price at any single cross-section somewhat impudent. By averaging prices over multi-month periods any temporaneous price distortions are hopefully ameliorated.

Given the global nature of this research a further amendment to the computed market capitalisations was required. In particular, the share prices sourced from Thomson Reuters are quoted in the local currency of their particular stock exchange. Thus, the computed market capitalisations were converted into a common metric – namely the US dollar (USD). To accomplish this, Thomson Reuters Tick History (2014) was drawn upon to source the relevant exchange rates on the fiscal-year end-date and the computed market capitalisations were converted into USDs.[22, 23] Table 6 details relevant Thomson Reuters ticker codes for the currencies required in the sample and Tables 7 through 9 detail the relevant exchange rates (in terms of USDs) for the various fiscal-year end-dates.

Table 6 - Thomson Reuter's ticker codes for relevant currencies

Nation	TR Currency Suffix
Canada	CAD=
Australia	AUD=
United States	USD=
United Kingdom	GBP=
Hong Kong	HKD=
South Africa	ZAR=
Philippines	PHP=
Japan	JPY=
India	INR=

Table 7 - Exchange rates for Stream 1 fiscal-year end-date

Date / Nation	31 Dec/08	31 Dec/09	31 Dec/10	31 Dec/11
Canada	1.2168	1.052	0.997	1.01965*
US	1.00	1.00	1.00	1.00
Philippines	47.47	46.50	43.645	43.8975*

Table 8 - Exchange rates for Stream 2 fiscal-year end-date

Date / Nation	30 Jun/08	30 Jun/09	30 Jun/10	30 Jun/11
Australia	0.95795	0.80695	0.84	1.07225

[22] The exchange rate sourced from Thomson Reuters Tick History (2014) was the end-of-day "average of bid and ask." When the fiscal-year end-date fell on a weekend or holiday there was no reported price. In these circumstance the simple average was taken of the quoted price of the closest preceding and succeeding days for which there was a quoted price.

[23] The currency for the United Kingdom and South Africa was further divided by 100 as the currency for the United Kingdom was quoted in pence while South Africa was quoted in cents on the Thomson Reuters database.

Table 9 - Exchange rates for Stream 3 fiscal-year end-date

Nation \ Date	31 Mar/08	31 Mar/09	31 Mar/10	31 Mar/11
United Kingdom	1.983	1.43275	1.51845	1.60325
Hong Kong	7.7827	7.7504	7.7645	7.779
Japan	99.83	98.855	93.465	83.16
India	40.03	50.57	44.825	44.535

3.3.8 Summary Statistics

Given that all the variables to be included in the statistical analysis have now been defined, this section provides a brief overview of the dataset by way of summary statistics. It was deemed appropriate to conduct the summary statistics on the actual dataset, prior to the multiple imputation process and data transformations to be undertaken in the succeeding section. Descriptive statistics and a correlation matrix follow as per Table 10 and 11. Generally, the correlation matrix exhibits just moderate levels of collinearity between the independent variables.

Table 10 - Descriptive Statistics[24]

```
      Code      StageOfDevelopment    Exchange         time
 0246.HK:   4   Explorer:7984      TSX    :4308   Min.   :2008
 0340.HK:   4   Producer:1380      ASX    :2556   1st Qu.:2009
 0575.HK:   4                      TSE    : 988   Median :2010
 0661.HK:   4                      ALT    : 420   Mean   :2010
 0705.HK:   4                      OTC    : 320   3rd Qu.:2010
 0835.HK:   4                      PIN    : 320   Max.   :2011
 (Other):9340                      (Other): 452
       MC              NetProfit                Debt
 Min.   :     27   Min.   :-1.580e+10   Min.   :-7.411e+09
 1st Qu.:   4348   1st Qu.:-3.966e+06   1st Qu.:-2.907e+06
 Median :  12407   Median :-1.374e+06   Median :-6.747e+05
 Mean   :  63897   Mean   :-5.413e+06   Mean   :-1.921e+07
 3rd Qu.:  41736   3rd Qu.:-4.030e+05   3rd Qu.:-1.834e+05
 Max.   :1414684   Max.   : 1.977e+09   Max.   :-1.330e+02
 NA's   :2516      NA's   :2134         NA's   :2146
   NetAssets           WorkingCapital        DebtToEquity
 Min.   :-4.061e+08   Min.   :-841731715   Min.   :-2884.4974
 1st Qu.: 1.771e+06   1st Qu.:     47001   1st Qu.:    0.0300
 Median : 7.547e+06   Median :   1294431   Median :    0.0800
 Mean   : 4.394e+07   Mean   :  11978594   Mean   :    0.3301
 3rd Qu.: 2.497e+07   3rd Qu.:   5408542   3rd Qu.:    0.2400
 Max.   : 1.733e+10   Max.   :8829260320   Max.   : 2299.1300
 NA's   :2152         NA's   :2173         NA's   :2194
 Profitability          MacroAbs           id
 Min.   :-12185.750   Min.   :1.539   Min.   :   1
 1st Qu.:    -0.520   1st Qu.:1.934   1st Qu.: 586
 Median :    -0.180   Median :2.065   Median :1171
 Mean   :    -3.968   Mean   :2.049   Mean   :1171
 3rd Qu.:    -0.070   3rd Qu.:2.294   3rd Qu.:1756
 Max.   : 26781.270   Max.   :2.403   Max.   :2341
 NA's   :2158
```

[24] For brevity of presentation the dataset was reshaped from "wide format" into "long format" in order that the years 2008, 2009, 2010 and 2011 be subsumed into the independent variable of time. Thus, instead of 2,341 units there are 9,340 (=2,341*4).

Table 11 - Pearson Correlation Results

	time	MC	NetProfit	Debt	NetAssets	WorkingCapital	DebtToEquity	Profitability	MacroAbs
time	1.000000000	0.096536953	0.0003547660	0.018397733	-0.0101905722	-0.0062709437	-0.0199844174	-0.0183142613	0.843060198
MC	0.096536953	1.000000000	-0.0111572578	-0.414200806	0.6332345961	0.4957330791	-0.0017778010	0.0120424496	0.126962746
NetProfit	0.000354766	-0.011157258	1.0000000000	-0.159829928	0.1886042160	0.1878096074	0.0001284637	0.0130492508	-0.003692366
Debt	0.018397733	-0.414200806	-0.1598299285	1.000000000	-0.8940017046	-0.7927364584	-0.0010951987	-0.0030733116	0.024605236
NetAssets	-0.010190572	0.633234596	0.1886042160	-0.894001705	1.0000000000	0.9255678928	0.0004170587	0.0004419987	-0.016558660
WorkingCapital	-0.006270944	0.495733079	0.1878096074	-0.792736458	0.9255678928	1.0000000000	-0.0001193892	0.0004929543	-0.005588496
DebtToEquity	-0.019984417	-0.001777801	0.0001284637	-0.001095199	0.0004170587	-0.0001193892	1.0000000000	0.1154598581	-0.017275587
Profitability	-0.018314261	0.012042450	0.0130492508	-0.003073312	0.0004419987	0.0004929543	0.1154598581	1.0000000000	-0.005474188
MacroAbs	0.843060198	0.126962746	-0.0036923657	0.024605236	-0.0165586603	-0.0055884956	-0.0172755870	-0.0054741876	1.000000000

3.3.8 Missing Data

The dataset under analysis suffers from a common problem: missing data. This is especially an issue given the large number of variables in the model, such that a missing observation on any one variable means that the whole unit (in this case, company) for that period of time is excluded from the statistical analysis. List-wise deletion is troubling as it also deletes a vast amount of observed information on interrelationships between the variables of interest. Indeed, for the three series under consideration herein such list-wise deletion results in series 1 retaining only ~11% (=182/1552) of the sample, series 2 retaining only ~33% (=211/639) and the entire series 3 (=135/135) sample would be lost.

In order to help remedy this problem multiple imputation is employed to impute the missing values. Multiple imputation involves Monte Carlo simulation to guesstimate the missing values m times (5 is generally taken as a minimum acceptable value for most datasets) and thereby create m datasets. Each of these m datasets is then statistically tested as per normal before combining the estimates to come from these statistical tests so as to incorporate the degree of uncertainty concerning the guesstimates into the final estimates (Rubin, 1987; Schafer, 1997). Indeed, the literature is in consensus that simple list-wise deletion generally produces biased and inefficient estimates and, moreover, that multiple imputation generally trumps such list-wise deletion (Little & Rubin, 1987).

To accomplish this multiple imputation process, the Amelia package (Honaker, King, & Blackwell, 2011) - via the R statistical package - is deployed. An assumption of Amelia, and most multiple imputation methodologies, is that the missing data is missing at random such that the absence of data is a function of observed values rather than missing values (Honaker et al., 2011). Furthermore, Amelia assumes that the completed dataset is multivariate normal. However, NRS variables are generally strongly skewed to the right. Consequently, these variables will need to be transformed to help support the multivariate normality assumption underlying Amelia. Such transformations will complicate the interpretation of the ultimate statistical results, however, this complication is deemed necessary in order to conduct the statistical analysis. It is noted that the model to be tested also includes categorical data, specifically stage-of-development and stock exchange, which may thus require a more involved transformation. Fortunately these categorical variables do not need to be transformed as Amelia handles categorical variables as well as models specifically tailored for categorical variables (Honaker et al., 2011; Schafer, 1997; Schafer & Olsen, 1998).

In transforming the variables, two different kinds of transformation were found to work best depending on the variable, namely cube-root transformations and log transformations.[25] A particular complication here was that many of the variables (e.g. net profit) can assume any point on the real number line (positive, 0 or negative) - an issue as many standard transformations are not applicable for all values – for instance, the log of negative values and 0 is undefined. Thus, a function was created in R that involved taking the log of the absolute value before reimposing the correct sign - the neg.log function (Whittaker, Whitehead & Somers, 2005; John & Draper, 1980).[26] Similarly, the cube root was tested because the sign of the transformed variable is retained and 0s remained 0s (Cox, 2011). A principle reason why the neg.log function was sometimes preferred to the cube root function and vice versa was that the transformation would sometimes, rather than producing normality, produce a bimodal distribution centred about 0. That is, in order to avoid the production of bi-modal variables, either neg.log or the cube root was applied. It is important to note that this bi-modality – although successfully avoided - was not a product of the underlying data, but rather an outcome of the transformation process itself. In order to illustrate the impact of these transformations (the aggregation of series 1 through 3) Figures 18 through 25 are provided. For Figures 18 through 25, the histogram on the left represents the untransformed variable, while the histogram on the right represents the transformed variable. The cube root transformation was applied to net profit, net assets, working capital and profitability while the neg.log transformation was applied to market capitalisation, debt, debt-to-equity, and exploration expenditure.[27]

[25] Here log refers to the natural log; e ~ 2.718

[26] neg.log <- function(x){ sign(x)*log(abs(x) + 1) }

[27] An important point concerning exploration expenditure is that this accounting-based PVF is only available for ASX listed companies. As such, this variable is only available and considered for stream 2.

Figure 18 - Histogram of market capitalisation and its neg.log

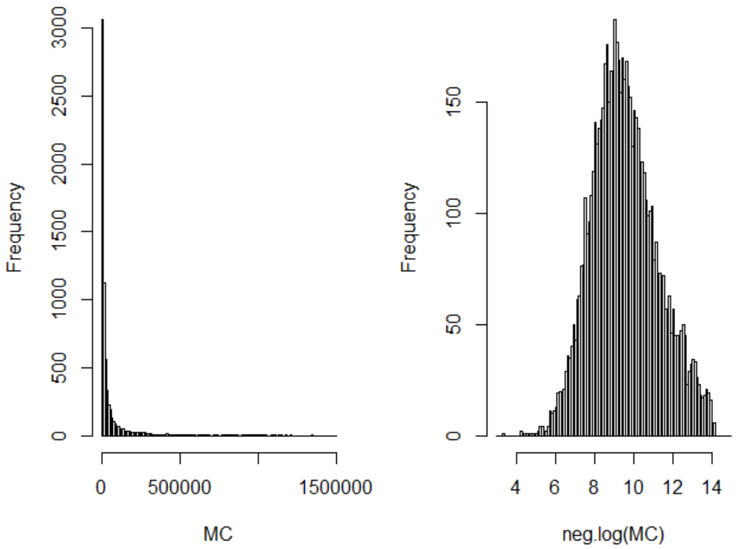


Figure 19 - Histogram of net profit and its cube root

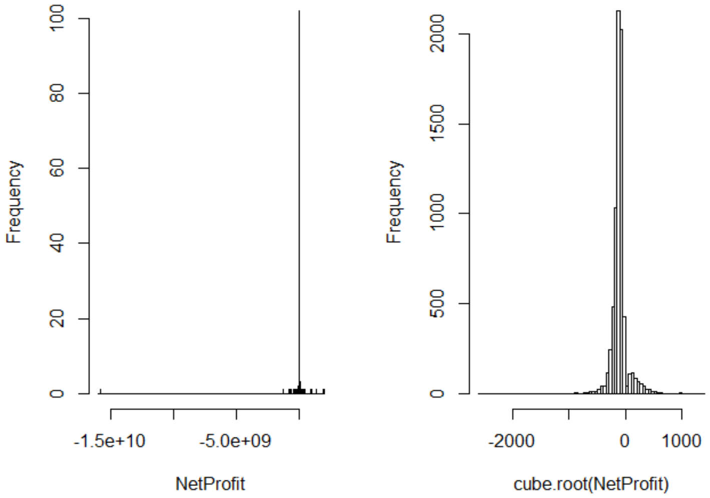


Figure 20 - Histogram of net assets and its cube root

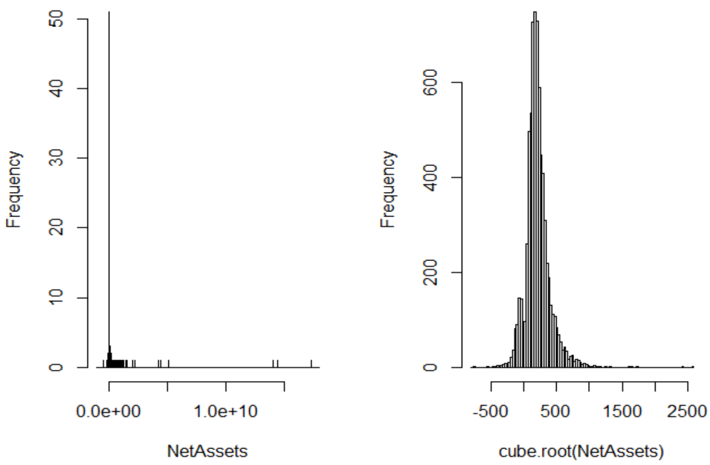


Figure 21 - Histogram of working capital and its cube root

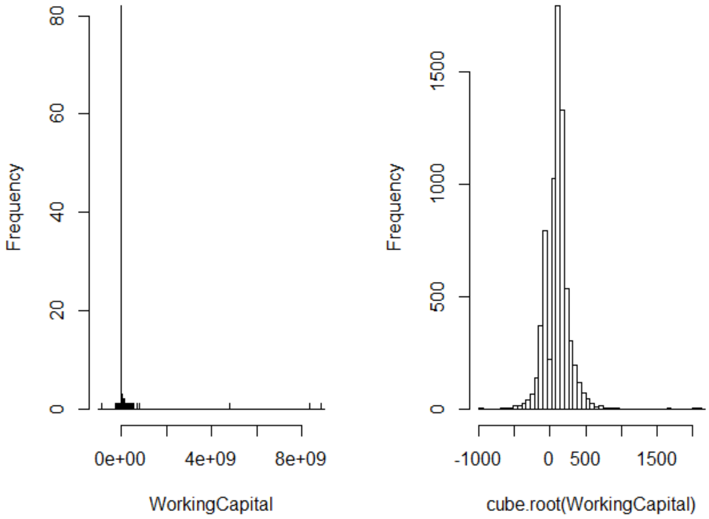


Figure 22 - Histogram of profitability and its cube root

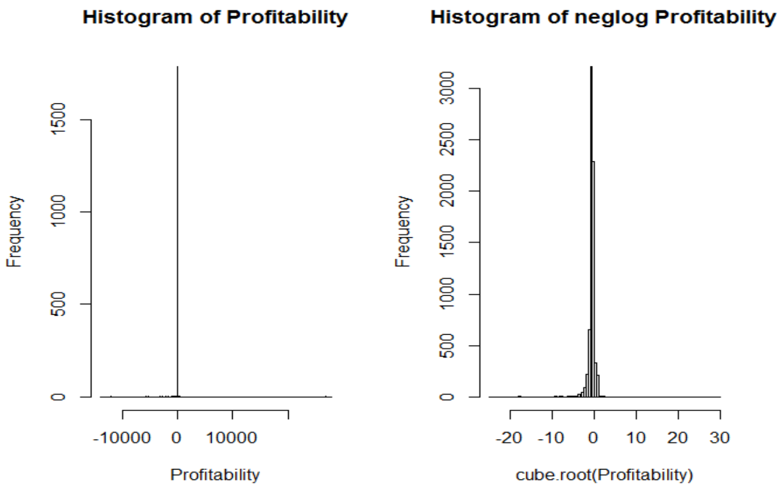


Figure 23 - Histogram of debt and its neg.log

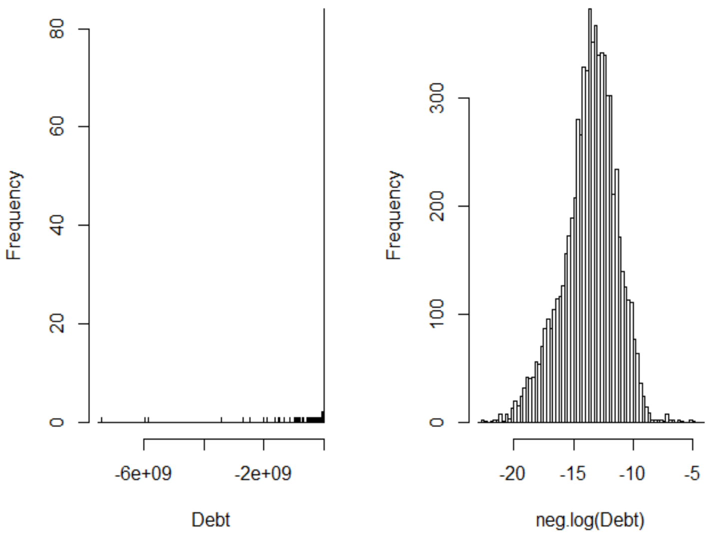


Figure 24 - Histogram of debt-to-equity and its neg.log

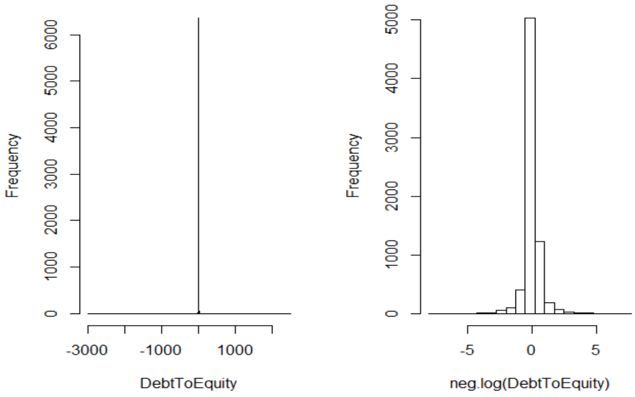
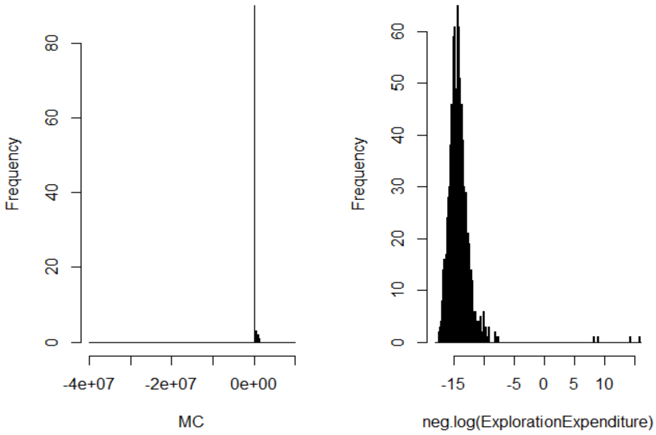


Figure 25 - Histogram of exploration expenditure and its neg.log



Having supported the assumption of multivariate normality via these transformations Amelia was run to create 5 complete datasets. Given that this is panel data, a lag/lead model was employed to impute these datasets (Honaker et al., 2011). The code used in R to perform these feats is listed in Insert 1 of Appendix B.

To provide some sense of the imputation model, as well as the original degree of missingness, Figures 26 to 33 are provided (via the Amelia package). Under Figures 26 to 33, the black-lined graph denotes the distribution of observed values while the red-lined graph denotes the distribution of average imputed values. Figures 26 to 33 also note the extent of missingness for each of the PVFs (Honaker et al., 2011). Thus, in terms of missingness, it is seen that exploration expenditure is especially high, in excess of 80%, while all the other PVFs hold levels of missingness between 22.8% and 26.9%.

Figure 26 - Observed and imputed values of market capitalisation

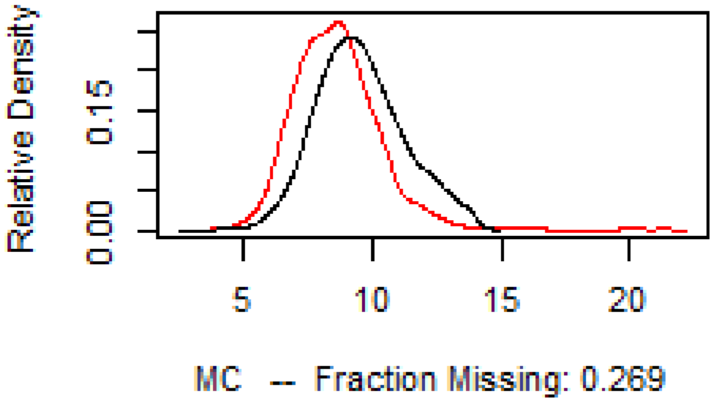


Figure 27 - Observed and imputed values of net profit

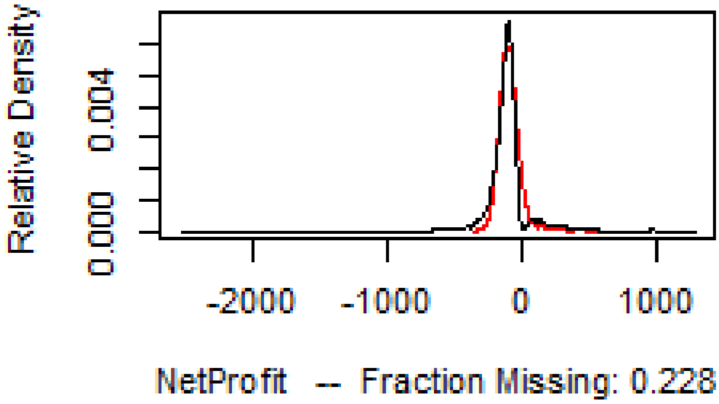


Figure 28 - Observed and imputed values of debt

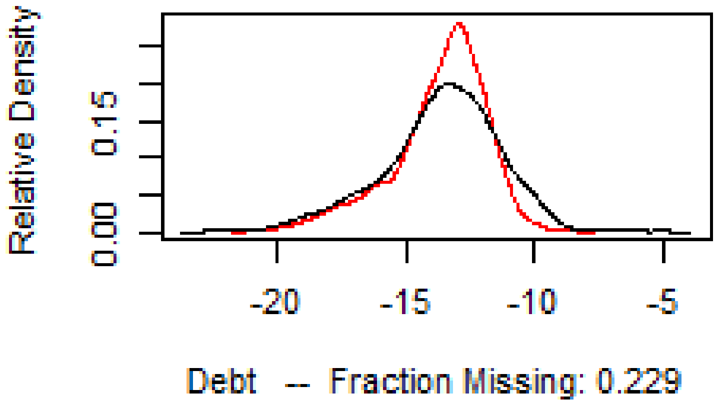


Figure 29 - Observed and imputed values of net assets

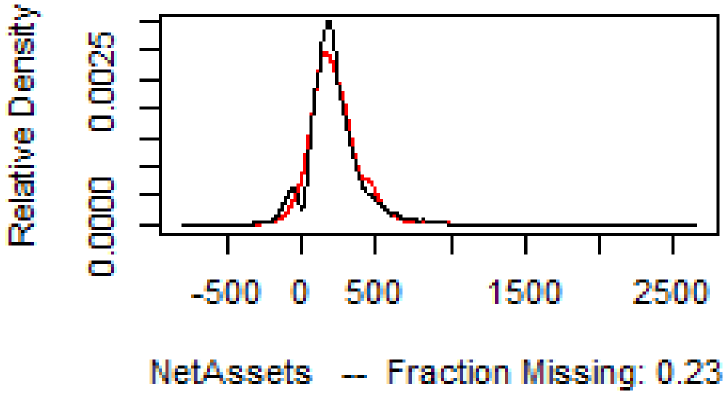


Figure 30 - Observed and imputed values of working capital

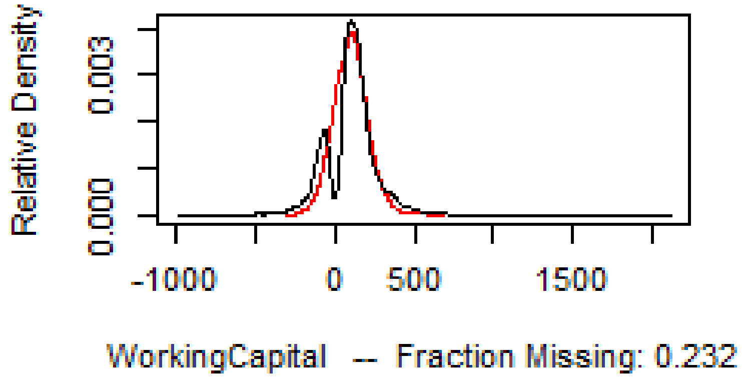


Figure 31 - Observed and imputed values of debt-to-equity

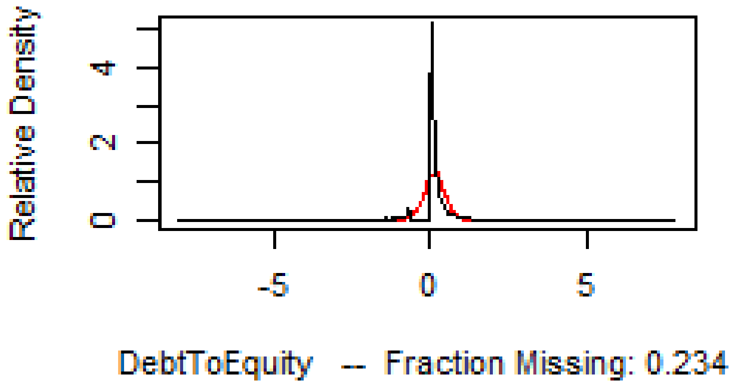


Figure 32 - Observed and imputed values of profitability

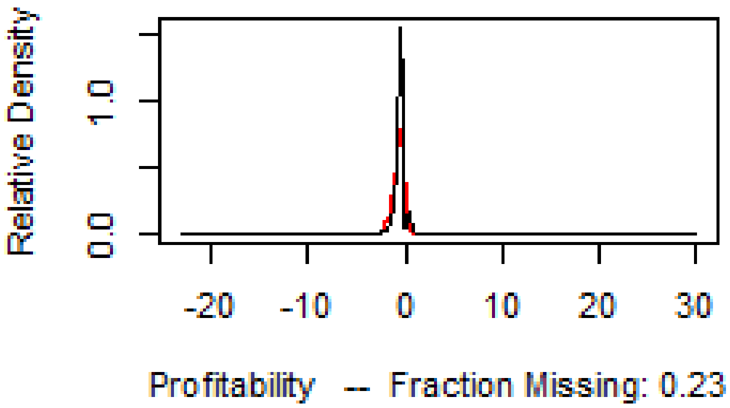
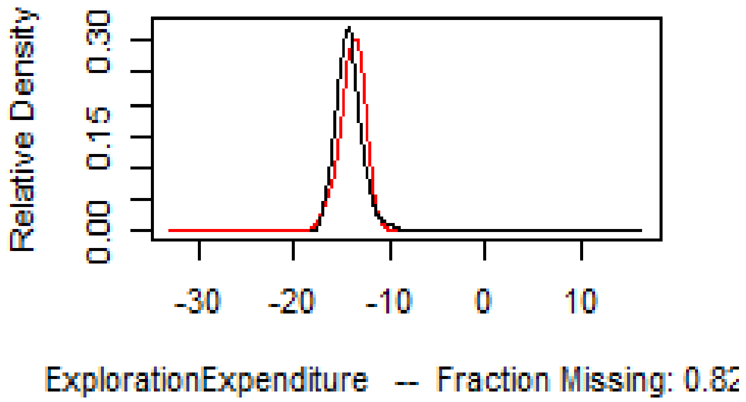


Figure 33 - Observed and imputed values of exploration expenditure



Meanwhile, Figures 34 to 41 help communicate the accuracy of the imputed results. This is achieved by supposing, successively, that each observed value is actually missing and then creating multiple imputations for that missing value. These multiple imputations are translated into confidence intervals demonstrating the range of imputed values produced by Amelia. Employing these confidence intervals, Figures 34 to 41 compares where the hypothetically missing value was actually located to help provide a sense of the accuracy of the imputation model. In particular, the estimated position is graphed against the actual position such that a line where y=x represents a 'perfect' imputation model with 100 percent accuracy. To aid visual inspection, each line is also plotted in terms of a 90 percent confidence interval. The number of these confidence intervals crossing the y=x line demonstrates how many observations Amelia was able to confidently guesstimate (Honaker et al., 2011).

Figure 34 - Observed versus imputed values of market capitalisation

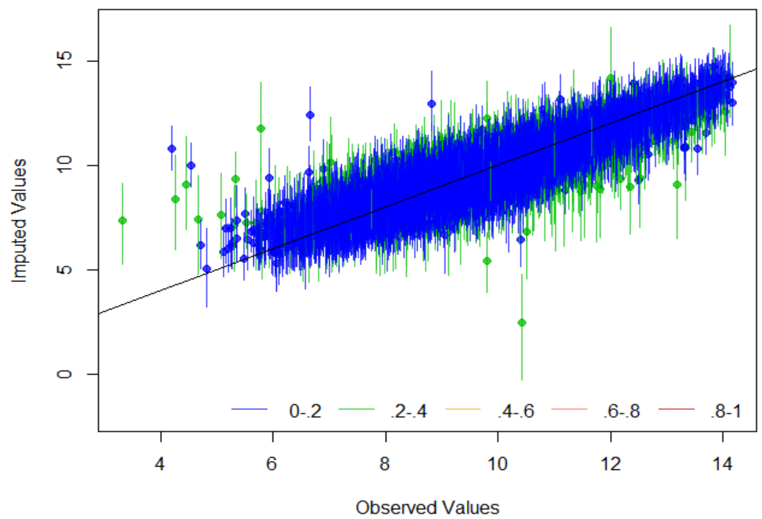


Figure 35 - Observed versus imputed values of net profit

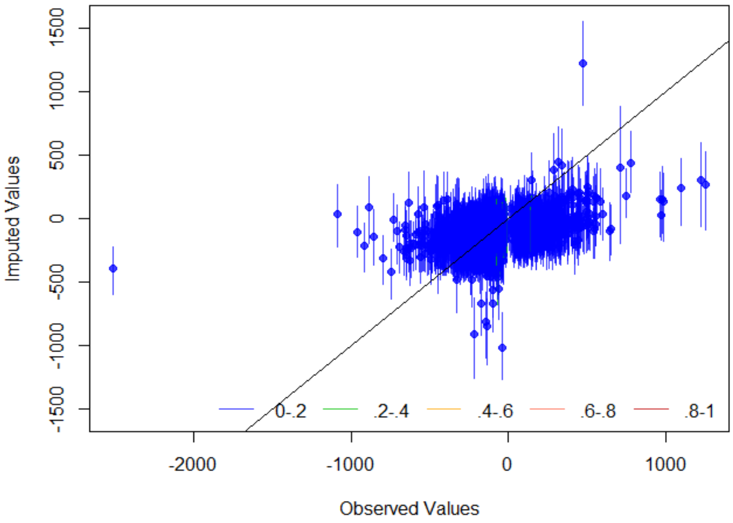


Figure 36 - Observed versus imputed values of debt

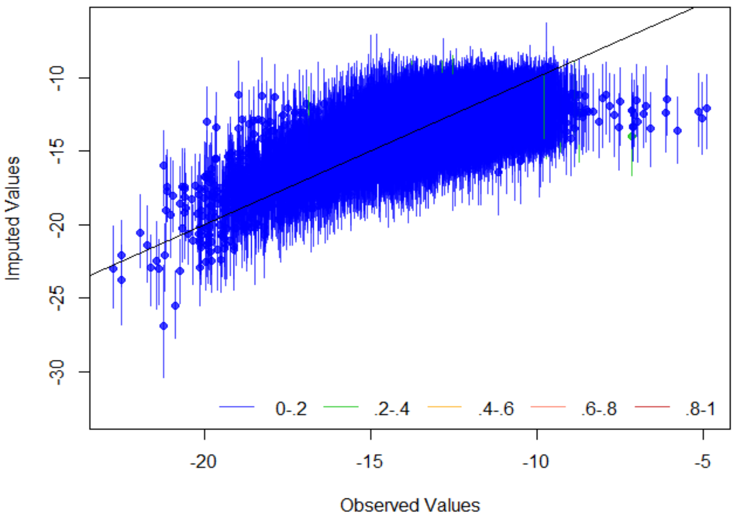


Figure 37 - Observed versus imputed values of net assets

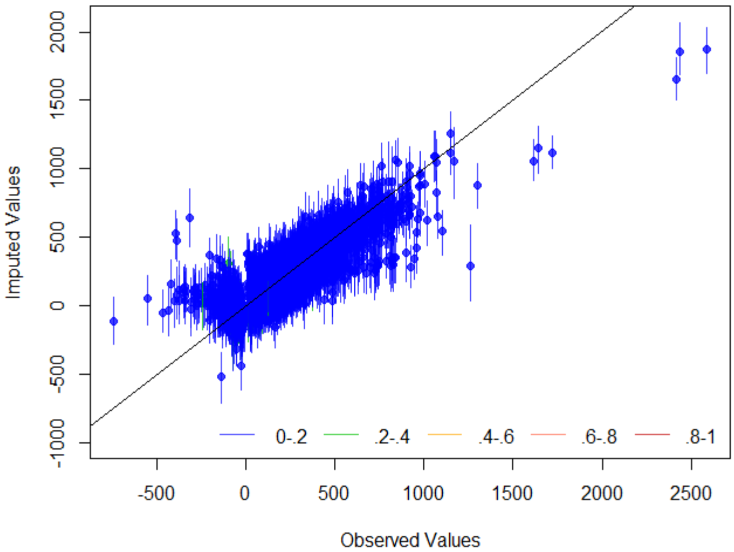


Figure 38 - Observed versus imputed values of working capital

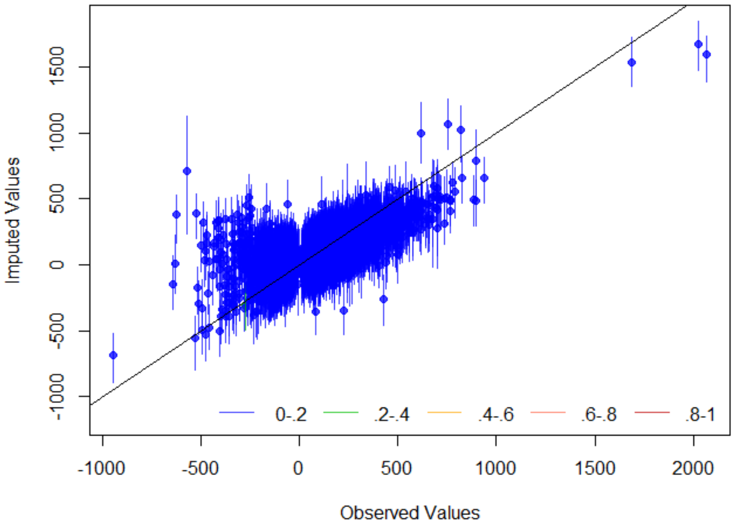


Figure 39 - Observed versus imputed values of debt-to-equity

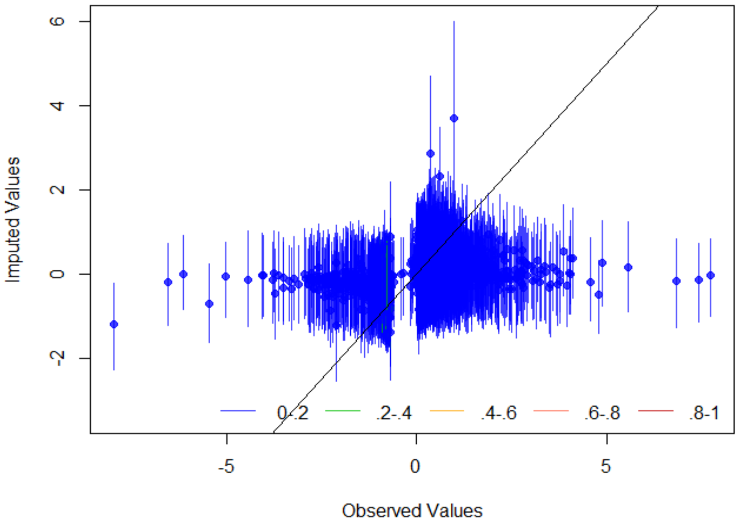


Figure 40 - Observed versus imputed values of profitability

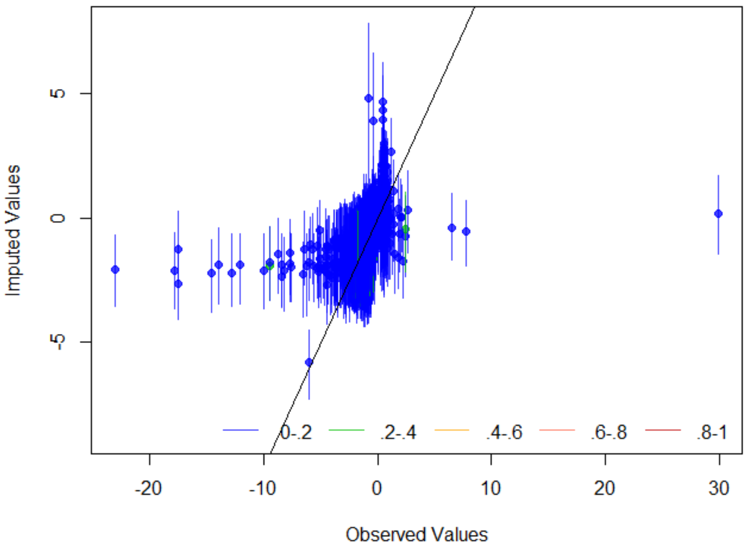
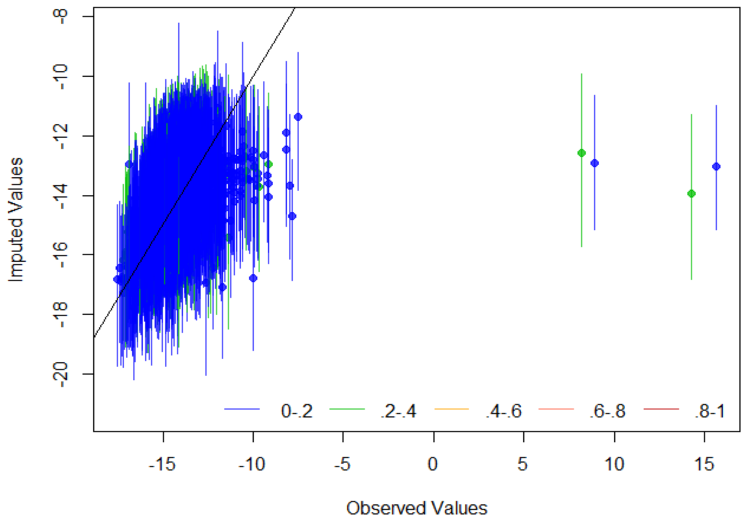


Figure 41 - Observed versus imputed values of exploration expenditure



3.3.9 Market Capitalisation Cut-off

As noted, this research is focussed on companies with a market capitalisation less than US$1.5 billion. Any company with a market capitalisation in excess of $1.5 billion has already been struck from the sample. However, the original dataset included missing market capitalisations and, now that market capitalisations have been imputed, some may be over the US$1.5 billion for any of the four periods. Thus, the five imputed datasets were next filtered to identify any companies who, for any period, hold a market capitalisation above US$1.5 billion.[28] For the five streams, 17 unique companies were identified with market capitalisations in excess of US$1.5 billion. Consequently, these 17 companies are removed, over all five imputed datasets, prior to statistical. This reduced the final sample, from an initial 2,341 firms to 2,324.

3.3.10 Section Summary

This section has served as preamble to the statistical analysis to follow. In particular the manner in which the dataset was refined was considered and, to help overcome the potential for omitted variable bias, the inclusion of non-accounting categories of PVFs to the analysis was discussed. This involved the creation of a novel commodity price index (CI_{NRS}) designed to reflect the commodity-type composition of the NRS. Furthermore, the issue of endogeneity was considered and it was decided to employ a lag-lead model to help ameliorate this potential limitation. Another difficulty to arise, a product of the global nature of the research, was the issue of differing fiscal years

[28] As a neg.log 1500000 is equivalent to 14.22098 – any companies possessing market capitalisations above 14.22098 were struck from the sample.

across nations. Unfortunately the heterogeneity of fiscal years was not able to be resolved and is a limitation (form of measurement error) impacting the analysis. A final major difficulty was that of missing data, and the work-around implemented was also considered in this section.

3.4 Preliminary Analysis

Panel data analysis was next conducted for the three streams. For brevity, results are presented concurrently. Given the five datasets, each must be analysed separately and then combined. In this study, the results are combined via bootstrapping—a methodology suggested by King, Tomz and Wittenberg (2000).

In general terms bootstrapping involves choosing n random draws from a sample of size n. Random drawing is conducted with replacement such that the selection of a unit for inclusion in the bootstrapped sample does alter that unit's likelihood of being selected in future draws, such that the same unit may be repeated in the bootstrapped sample up to n times. If replacement was not allowed the bootstrapped sample would be redundant as it would simply replicate the original sample. Having thus derived a bootstrapped sample the chosen statistical test is conducted and the results of this statistical test are saved. This process is then repeated a large number of times such that a large number of statistical results are derived from a large number of bootstrapped samples. From this distribution of statistical results (estimates) the likely true value is selected (for instance, the median value) with, if sought, it's associated confidence interval.

For the case at hand, bootstrapping is conducted by randomly drawing a new sample of 20 percent from each of the five imputed datasets and then conducting the statistical analysis. This process is repeated so as to produce 1,000 simulated datasets with the results of the statistical analysis conducted on each of these datasets. The median result from the distribution of statistical results is taken to represent the combined result.

The first statistical analysis to be considered is whether some more complicated form of panel data analysis might not be trumped by a simpler pooled model. Thus, the fits of the pooled model is compared to a fixed effects model by way of an F test.[29] The R code constructed to conduct this test is presented in Insert 2 of Appendix B.

[29] Note that the fixed effects model does not allow time-invariant independent variables, thus stage-of-development and exchange, although include in the code for the fixed effect model below, are not capable of being included in the fixed effects model.

The resulting median value for the p-value of the F test is 0.004522962 - this value is well below 0.05, suggesting that there is significant variation between the firms. Consequently, a fixed-effects model is preferred, as it explicitly models individual heterogeneity, over a simpler pooled model.

In modelling such individual heterogeneity, the error term is often considered in two parts: (1) generic idiosyncratic error and, (2) error which is individual-specific and permanent through time. The capacity to control for the latter part of the error component is, as previously noted, a strength of panel data analysis; other models cannot capture the individual-specific error component and consequently have higher levels of omitted variable bias than would otherwise be the case. Importantly, this individual-specific and permanent error component can be correlated with independent variables in the model. If such correlation does exist, the fixed effects model is preferred – whereas if this individual and specific and permanent error is distributed independently of the independent variables the random effects model is preferred. In order to decide between the fixed and random effects model, the Hausman test is conducted, with the relevant code provided by Insert 3 of Appendix B. The median result for the p-value for the Hausman test is 0.00185709 - as this value is less than 0.05, the fixed effects model is preferred over the random effects model.

Having decided on the fixed effects model, some further diagnostic checks are performed to check a number of assumptions that might otherwise endanger the validity of the model.[30] Firstly, the model will be checked for heterogeneity via the Breusch-Pagan test as per Insert 4 of Appendix B. The median of the p-value for the Breusch-Pagan test is 2.2e-16 – which is less than 0.05 indicating that heteroskedacity is present and an issue that should be controlled for.

Subsequently, a Dickey-Fuller test was conducted as per Insert 5 of Appendix B. The median resulting p-value for the Dickey-Fuller test was 0.01, which, being less than 0.05, indicates that unit roots are not present. Thus, stochastic trends (non-stationarity) in the data is not a concern.

Finally, the possibility of serial-correlation is tested for via Wooldridge's test specifically designed for short fixed effects panels as depicted in Insert 6 of Appendix B

[30] The possibility of cross-sectional dependence is not tested for as it is beyond the scope of the research. Nonetheless the importance of cross-sectional dependence in panel data has been an especially active area of research in the past few years with a number of break-throughs.

(Croissant & Millo, 2008). The resulting median p-value of 3.887099e-123 is less than 0.05 indicating that serial correlation is an issue.[31]

The tests thus far have revealed that a fixed-effects model is preferred but there are, also, issues with both (1) heteroskedacity and (2) serial-correlation in the panel data. In order to overcome these issues a sandwich estimator (i.e. a robust covariance matrix estimation) is employed. In R, the “vcovHC function” (see Torres-Reyna 2011) estimates three forms of heteroskedacity (i.e. White1, White2 and Arellano). The Arellano method is selected because it is ideal for fixed effects models (Torres-Reyna, 2011) and is well suited for situations where the unit dimension (n) is large and the time dimension (t) is small (Croissant & Millo, 2008). Moreover the Arellano method is robust against not only heteroskedacity but also serial correlation (Croissant & Millo, 2008).

3.5 Panel Data Analysis and Results

Thus, the fixed-effects model via a sandwich estimator (the Arellano method) is employed to test the five datasets and the results are combined to produce the final estimates. However, instead of applying a bootstrap methodology an alternative methodology to combine results based on the work of Rubin (1987) is employed (as discussed by Carlin, Li, Greenwood & Coffey, 2003). This method involves running the statistical analysis separately across the five datasets and saving the resulting regression coefficients and their respective standard errors. The combined coefficient is found via the following formula:

$$\overline{Q} = \frac{1}{m}\sum_{j=1}^{m}\hat{Q}_j.$$

In order to find the standard errors the within-imputation variance and the between-imputation variance are respectively calculated as:

$$\overline{U} = \frac{1}{m}\sum_{j=1}^{m}U_j\,.$$

$$B = \frac{1}{m-1}\sum_{j=1}^{m}\left(\hat{Q}_j - \overline{Q}\right)^2.$$

Before total variance is calculated as:

[31] The median-p value was 2.519564e-12 for series 1.

$$T = \overline{U} + \left(1 + \frac{1}{m}\right)B.$$

The standard error is found by taking the square root of T.

Thus, the fixed-effects model is run using the Arellano method sandwich estimator and combining the results according to Rubin's (1987) aforementioned equations. The coding used to complete this is recorded by Insert 7 of Appendix B.

The final statistical results are presented in Table 12.

Table 12 – Statistical results

Stream 1	Estimate	SE	t value
lag(NetProfit, 1)	0.0001484367	0.0108002696	0.01374379580
lag(Debt, 1)	0.0001048826	0.1182865329	0.0008866825
lag(NetAssets, 1)	0.000377648	0.014918291	0.0253144277
lag(WorkingCapital, 1)	-7.163933e-05	1.151640e-02	-0.00622063
lag(DebtToEquity, 1)	0.004251329	0.166733734	0.025497713
lag(Profitability, 1)	-0.005695866	0.150756082	-0.0377819980
lag(MacroAbs, 1)	0.5077199	0.1985411	2.55725338
lag(ExplorationExpenditure, 1)	-0.01864598	0.09293170	-0.20064176

Thus, having conducted the analysis and given the resulting t values, only one PVF is significant, namely CI_{NRS} (the proxy for macroeconomic conditions). That is, none of the accounting-based PVFs were found to be significant and, as a fixed-effects model was employed, stage-of-development and exchange could not be included in the model given that these variables are time-invariant. Thus, this chapter does not support the value-relevance of accounting variables to the NRS. This finding supports those authorities who suggest that accounting-based authorities are of little utility insofar as the NRS is concerned. Nonetheless, this analysis suffered from a number of limitations that may impact these results—e.g. omitted variable bias (stage-of-development and exchange were not included) and measurement error (disparate fiscal years were aggregated). Moreover, the NRS is characterised by very noisy prices (large standard errors) that makes uncovering any signal of value-relevant difficult even if an underlying effect is present.

3.6 Chapter Summary

This chapter focussed upon accounting-based PVFs within the NRS. The received literature was reviewed to identify accounting-based PVFs. Having identified accounting-based PVFs, statistical analysis was conducted so as to determine the significance of accounting-based PVFs in practice. In performing this statistical analysis, the accounting-based PVFs were supplemented with a number of non-accounting PVFs. By necessity, the full exposition of these non-accounting PVFs is the subject of later chapters. In this manner, by the by, the statistical analysis affirmed the significance of commodity prices – a PVF considered in Chapter 7. Nonetheless, the analysis failed to support the value-relevance of accounting information, although there were a number of limitations that may have contributed to this result.

Having identified accounting-based PVFs and empirically tested their value-relevance, the following Chapter builds on this work by considering capital raisings. Capital raisings represent a principal feed-in to accounting-based PVFs because NRCs are, predominately, at a pre-production stage-of-development. Accordingly, the value-relevance of capital raisings forms the subject of the succeeding Chapter.

Chapter 4: Capital Raising Factors

4.1 Chapter Introduction

The value-relevance of accounting information is related to the practice of capital raisings, with monies raised through capital raisings directly captured by (that is, reflected in) accounting statements. From this perspective, capital raisings can be viewed as a special type of accounting-based PVF. Indeed, capital raisings are the principal means by which most NRCs (usually having little or no regular revenue) replenish capital reserves – and, thereby, fund business development and stave off insolvency. This Chapter begins by examining the role of capital raisings within the NRS generally. Subsequently, PVFs associated with IPOs and SEOs are considered. This Chapter concludes with an empirical investigation of capital raisings.

4.2 Raising Capital in the NRS

Raising capital is an essential function for the NRS. This is because the majority of NRCs are fundamentally venture-capital concerns, focussed on exploration and the appraisal of embryonic natural resource deposits, without the internally generated financial wherewithal to support their activities. Accordingly, NRCs generally operate along the margin of the insolvency precipice, raising a limited pool of capital, expending this capital in a short time frame – generally within a matter of months, before again approaching the capital markets to revitalize waning cash reserves. Even the small minority of NRCs operating profitable mines typically draw upon the capital markets to fund major CAP-X expenditures (e.g. mine expansions). In fact, no resource company would ever attain the station of miner were it not nursed and supported, through frequent capital infusions, during its inception (Low, 2011). Consequently, NRCs are dependent on capital injections from external financial markets – the most usual being equity markets.

Equity markets are the primary source of funding for the NRS. Low (2011) notes that equity, as the quickest means by which to raise capital, is an especially appropriate source of capital for NRCs. Speedy access to capital allows NRCs to act on opportunities quickly, such as a new project acquisition, and thus leverage an advantage of their small size – a capacity for rapid decision-making (Low, 2011). Moreover, due to the high levels of uncertainty encumbering the sector equity is usually the only feasible source of capital. In fact, given the heightened level of uncertainty involved, the NRS's predisposal towards equity is in accordance with pecking order theory: whereby firms, having the option of internal funds barred to them, would first elect to use debt, then convertible debt, and finally, if the aforementioned options were not possible, equity. This is supported by Lee, Lochhead, Ritter and Zhao (1996) who find that the least expensive form of capital is straight bonds, followed by convertible bonds, before SEOs, and finally, most expensive, the IPO. External financing is generally more expensive than internal financing due to imperfections in the credit market – including the asymmetrical information divide between lenders and borrowers. Hence, the NRS, given the extreme-uncertainty in its business model, is generally forced to rely on the most expensive form of financing – equity. However, once a NRC has defined promising resources, and moreover, validated the feasibility of these resources for mining (i.e. once reserves have been demonstrated) debt is generally able to be secured at sufficiently attractive terms. Thus, for NRCs at a more advanced stage-of-development, where uncertainty is resolved to acceptable levels, debt is an important source of funds. Table 13 helps to validate this point:

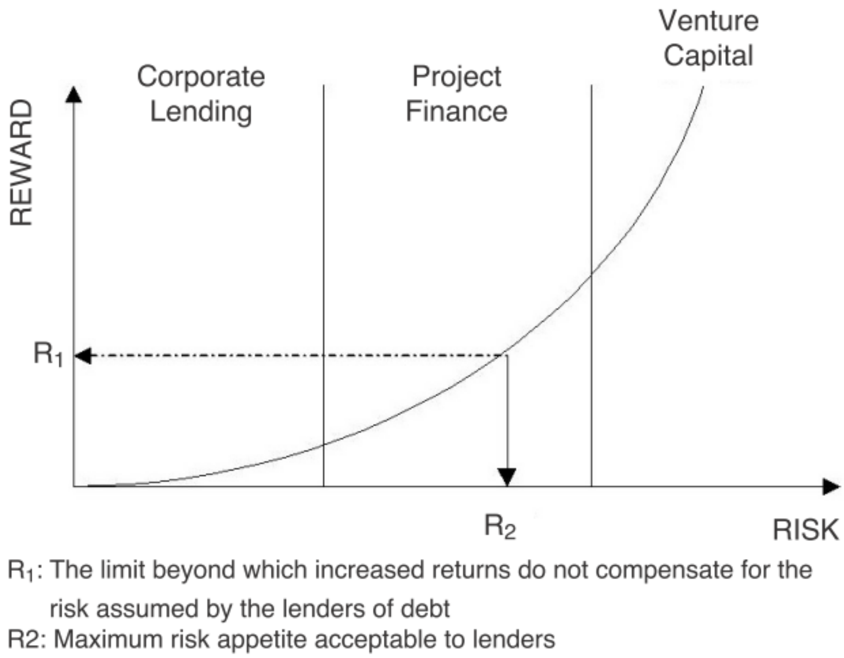
Table 13 - Funding given stages-of-development

Development phase	Type of funding	Source of funding
Prospecting	Equity	Shareholders
Initial Exploration	Equity	Shareholders
Advanced Exploration	Equity/ Venture Capital	Shareholders Specialized Resource Funds
Pre-Feasibility Study	Equity/ Venture Capital/ Quasi-Equity	Shareholders, Specialized Resource Funds, Selected Banks
Bankable Feasibility Study	Equity/ Quasi-Equity/ debt (with recourse)	Shareholders, Selected Banks, Commercial Banks
Construction	Equity/debt (limited recourse)	Shareholders, Selected Banks
Post-Commissioning (completion)	Equity/debt (non-recourse)	Shareholders, Selected Banks

Source: Benning (2000)

However, only a small subset of the NRS is at a sufficiently advanced stage-of-development to source debt funding. Figure 42 illustrates the risks limits beyond which debt funding is not available.

Figure 42 - Funding given risk-reward relationship



Source: Benning (2000)

Consequently, most NRCs are barred from debt funding because, as an investment proposition, their risk/reward profile is too extreme. Accordingly, most NRCs depend on equity funding – IPO and subsequently SEOs – to advance their business model.

Consequently, the prudential management of equity raisings is of the utmost importance to a NRC; a well-managed capital raising insures the viability of the firm as a going-concern, at least until the next capital raising is called, and demonstrates an endorsement by the market of the company's strategy. Meanwhile, a poorly managed or inopportune capital raising can inflict serious damage to a company's prospects, market standing and price – even when there is no likewise underlying destruction of the firm's assets or the viability of its business plan. Enfolded in the capital raising process is the phenomenon of "self-fulfilling" prophecy, where increased market valuations often allow additional funds to be raised more easily with relatively lower levels of dilution, which again increases market value again facilitating future capital raisings and associated business development in a fortuitous self-sustaining cycle.

Likewise, falling market values makes it profoundly more challenging to successfully execute capital raisings, and failed capital raisings can have a devastating impact on market values and sentiment, which again vastly increases the difficulties involved, and the required dilution of existing holders, of the still required capital raise.

This perilous financial position is encapsulated by Jain, Jayaraman and Kini (2008, p.168) for internet IPO stocks – a market segment in many ways analogous to the NRS:

> "Since cash flow negative firms are not yet self-sufficient and, therefore, dependent on external financing to continue to operate, the inability to raise additional capital results in a vicious cycle of events that can quickly lead to delisting and even bankruptcy."

Thus, the unique nature of the NRS fundamentally separates it from the broader market. In particular, an industrial firm with earnings can concentrate on protecting, optimising and growing its earnings, and, if successful, can fairly expect that this success will eventually reflect in market value. In contrast, an exploration-focussed NRC often has the exact opposite conundrum, where it must first improve market value to increase its capital stores, so that it may employ these capital stores to explore and develop prospects into mines which generate earnings, at which point it may more surely justify and build its market value in the manner of an industrial company.

To summate: a NRC's relationship with the equity markets commences with a successful IPO and subsequent listing to a stock exchange. However, the conclusion of a successful IPO is generally, in the case of NRCs, but the first of many calls to the equity markets for additional capital; with a succession of SEOs typically in train – necessary to sustain the NRC's continued development. This section first surveys PVFs associated with IPOs as it applies to the NRS. Subsequently, PVFs associated with SEOs are considered.

4.3 The Value-relevance of IPOs

The boom in the NRS that marked the early 21st century was signalled, among other measures, by a dramatic upsurge in the IPO market for NRCs. Consequently, the means by which the equity markets value new NRC listings - whether PVFs specific to the IPO process, or combinations thereon, are involved - represents an important research question for this thesis.

There is extensive literature examining the market's valuation of IPOs. A principal result of this research is that IPOs are, on the whole, under-priced - especially during buoyant market conditions (Ibbotson & Jaffe, 1975; Ritter, 1984; How, Izan, & Monroe, 1995). Still, the literature generally concludes that, despite the discount IPO investors enjoy to the initial market price, in the long run, such initial outperformance typically gives way to underperformance (Ritter, 1991; Aggarwal, Leal, & Hernandez, 1993; Lee, Taylor, & Walter, 1996). While the definitive explanation for IPO under-pricing remains the subject of debate, many leading theories are based upon the concept of information asymmetry: whereby the issuing firm, or, alternatively, the underwriters of the offer, possesses greater knowledge regarding the intrinsic value of the offering vis-à-vis the purchasing public. Consequently, the issuing firms must under-price the offer relative to intrinsic value to compensate investors for their knowledge disadvantage and implicit risks that they are therefore assuming (Baron, 1982; Allen & Faulhaber, 1989).

In a similar vein, Beatty and Ritter (1986) argue that the extent of IPO under-pricing is positively related to the level of uncertainty concerning the post-listing price. Risk involves uncertainty, and IPOs which are difficult to value, and for which it is therefore difficult to predict a post-IPO price, are usually under-priced to a greater degree so as to compensate investors for the additional risk.

Yet another strong explanation for IPO under-pricing is Rock's (1986) model. The essence of Rock’s (1986) model concerns the tendency for attractively priced IPOs to be quickly secured by informed investors while uninformed investors are rapidly crowded-out. In order to compensate for this tendency, IPOs are (on average) under-priced (Rock, 1986). Lee, Taylor and Walter (1996) suggested a measure for this effect, namely, the promptness with which new IPOs are funded; where more attractively priced IPOs are funded more quickly. This effect has found empirical support – for instance, the rapidity with which IPOs are placed has been positively related to the degree of under-pricing by How et al. (1995).

Thus far, the discussion in this study into IPO pricing has relied upon general, non-sector specific, literature. But, given the distinctive nature of the NRS, it cannot be assumed that these generic results translate to the NRS. In fact, the extant IPO pricing research that explicitly targets the NRS does refute, on several points, the generic literature. To this end, IPO pricing research, focussed on the NRS, will be considered presently.

An early work to recognise the singular dynamics of the junior resource sector within the IPO market was Ritter (1984). He examined the hot IPO market that extended from Jan/80-Mar/81, a period over which the average initial return approached 50 percent, in juxtaposition to the cold IPO market which characterised the remainder of 1977-82 and for which the average initial return was only 16.3 percent. The research found that the hot IPO market was nearly entirely attributable to the stellar initial returns of resource companies – with a boom underway in oil and gas plays; while the non-resource sector barely registered any uptick in the initial returns of IPOs for the period. Notably, the extreme initial outperformance of resource companies was barely observable for large resource companies; the hot period was mainly due to the outperformance of the resource juniors - with resource companies holding sales of less than US$500,000 recording average initial returns of 140 percent. Furthermore, adopting an earlier iteration of Rock's (1986) model, Ritter (1984) found empirical support for a positive relationship between uncertainty concerning the post-listing price and average initial returns.[32] Interestingly, while this relationship was stationary for non-resource companies, there was no such stationarity for resource companies. Such a finding suggests that Rock's (1986) model does, at least in part, apply to the NRS, in spite of the sector's dynamic volatility.

Thus, Ritter (1984) found that, at least during certain periods, the IPOs of NRCs can exhibit more extreme under-pricing than the broader IPO market. Indeed, Kooli and Suret (2004), studying the Canadian IPO market, reported that companies in the mining sector enjoyed initial returns of 35.71 percent - higher than any other sector. Nonetheless, perhaps due to these high initial returns, Kooli and Suret (2004) found that companies in the mining sector underperformed in the long term.

Another relevant study, How (2000), motivated by Ritter (1984), examined the performance of 130 NRCs that listed on the ASX between 1979 and 1990. Like Ritter (1984), How (2000) also found significant under-pricing, reporting average under-pricing of more than 100 percent - significantly beyond that observed for industrial companies. Such a finding is understandable given the NRS's inherent uncertainty and unpredictability, obfuscating estimations of a NRC's shares prior to actual listing. Hence, invoking the work of Beatty and Ritter (1986), uncertainty concerning post-IPO value probably forces NRCs to steeply under-price their IPOs.

For How (2000), the most significant factor explaining the extent of under-pricing, was the duration between prospectus registration and listing; where shorter durations were related to greater levels of under-pricing. Rock's (1986) winner's curse explains why shorter durations between prospectus registration and listing would be related to greater levels of under-pricing: as suggested by Lee, Taylor and Walter (1996), the rapidity with

[32] Rock (1982) PhD thesis.

which IPOs are placed probably reflects the eagerness of informed investors, who effectively crowd-out less informed investors.

The other major explanatory variable uncovered by How (2000), to predict the level of under-pricing, was the prevailing market conditions present on listing - where buoyant market conditions were related to greater levels of under-pricing. How's (2000) finding that buoyant market conditions are related to increased levels of under-pricing, while depressed market conditions mitigate this effect, presages the importance of macroeconomic factors – the subject of a later section. How (2000) also found, in contrast to the broader literature, and reinforcing the unpredictable IPO pricing patterns of NRCs, that her sample did not underperform the market in the longer-term (i.e. three years post-listing). Equally surprising, How (2000) found that those NRC IPOs that were funded more slowly typically exhibited greater long-term performance. Such a finding is in discord with Rock's (1986) model, which implies that those issues funded most expeditiously represent the best value and would thus, presumably, enjoy superior long-term performance. How (2000) notes that such a result implies that informed investors cannot really select attractively priced IPOs – unless these informed investors are selling their shares shortly after the NRC debuts on the market.

Dimovski and Brooks (2008), motivated by How (2000), examined 114 gold-focussed NRC IPOs that listed on the ASX during the 1999-2004 period. For this sample, Dimovski and Brooks (2008) reported an average under-pricing of 13.3 percent - significantly less than that reported by How (2000). Dimovski and Brooks (2008) found that under-pricing is negatively associated with underwriters accepting options as part of the issue. This is reasoned to be due to underwriter's only accepting options in those cases where they can be reasonably sure of the post-listing price. The consequence of reduced levels of uncertainty concerning the post-listing price is to mitigate under-pricing. Supporting How's (2000) finding that prevailing market conditions are positively associated with the level of under-pricing, Dimovski and Brooks (2008) found that changes in the ASX All Ordinaries Index and the Gold Index[33] are both positively associated with greater levels of IPO under-pricing.

In a similar vein, research by Mcpherson (2011) into NRCs listing on the TSX Venture Exchange (TSX-V) from 2005-07 found that, on average, IPOs were under-

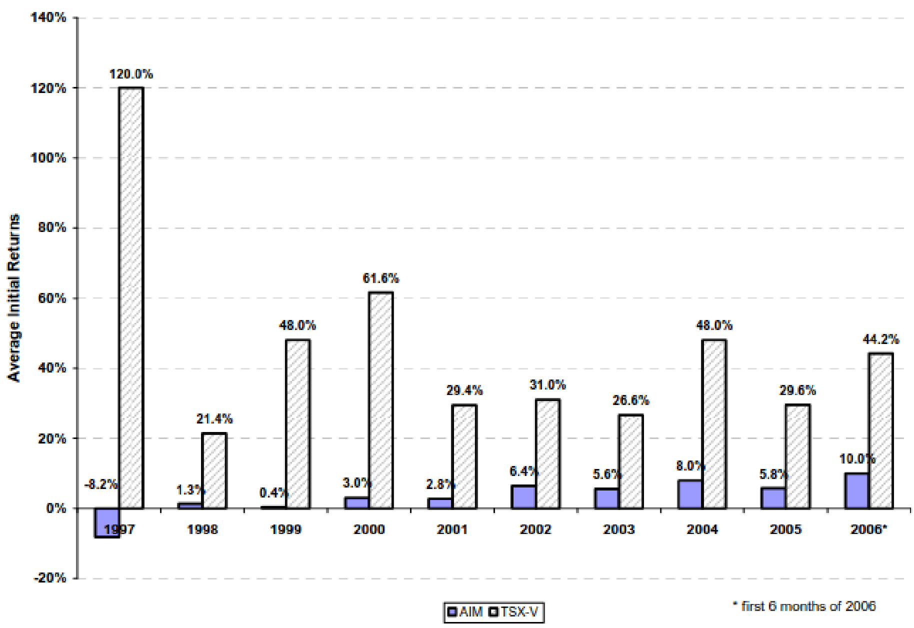
[33] An ASX index comprising gold companies listed on the ASX.

priced by 34.1 percent. The uniformity of the observed under-pricing, and the failure to relate the extent of the under-pricing to PVFs, led McPherson (2011, p.82) to conclude:

> "The fact that junior mining IPO's listed on the TSX-V show a constant degree of underpricing over time implies that investors do not build market specific factors (market sentiment and commodity price) into the listing price. Rather investors seem to demand a constant degree of underpricing regardless of the market situation to compensate them for the 'unknown' exploration risk."

Another IPO study to focus explicitly upon the natural resources sector is Smithson and Firer (2007). They investigated the IPOs of mining[34] stocks on the Toronto's TSX-V and London's AIM from Jan/97-Jun/06 and found that both markets exhibited significant under-pricing (refer to Figure 43).

Figure 43 - Initial excess returns by year on the AIM and TSX-V



Source: Smithson & Firer (2007)

However, as Figure 43 illustrates, the extent of under-pricing was an order of magnitude greater on the TSX-V: the average initial excess returns for the TSX-V was 38.5 vs. 6.3 percent for AIM.

The heightened under-pricing of the TSX-V was also linked to the amount of capital raised, specifically, new listings on the TSX-V who raised smaller amounts during IPO exhibited significantly greater levels of under-pricing. Smithson and Firer (2007)

[34]A point on terminology: Smithson and Firer's (2007) reference to *mining* does not mean that there sample only comprised mining companies. The vast majority of their sample comprised NRCs; only a small minority of their sample comprised companies with operational mines.

suggest that this may reflect the fact that smaller companies are inherently riskier and thus require greater levels of under-pricing to compensate IPO investors.

Furthermore, Smithson and Firer (2007) found that the new listings significantly underperformed post-listing for both the TSX-V and AIM. This underperformance was especially acute in the case of the TSX-V, where the large initial excess returns were typically completely reversed within approximately six months. This is consistent with the generic IPO literature, but contradicts the findings of How (2000).

Notably, Smithson and Firer (2007) organised their sample by stage-of-development—i.e. segregating by: exploration-stage, feasibility-stage, and mining-firms. All but six of the 943 mining companies listed on TSX-V were categorised as explorers, highlighting the fact that the TSX-V is dominated by early-stage NRCs. Given that the TSX-V was saturated with exploration companies, Smithson and Firer (2007) concluded that only the AIM was amenable to statistical analysis concerning the impact of stage-of-development, with the AIM hosting ~57, ~30, and ~13 percent being, respectively, exploration firms, feasibility firms, and mining firms. Stage-of-development was found to be a significant explanatory factor for post-listing performance on the AIM, with the average one year returns accruing to exploration, feasibility and mining companies being -5.7, 19.1, and 24.9 percent, respectively.

Still, Smithson and Firer (2007) did not find any empirical evidence of a relation between stage-of-development and IPO under-pricing—although such a relation could be expected on theoretical grounds. In particular, Beatty and Ritter (1986) argue that the level of under-pricing at IPO is positively related to uncertainty concerning post-listing prices—that is, firms for whom it is difficult to reliably value would be expected to exhibit higher levels of under-pricing. Applied to the NRS, mining, and late-stage development NRCs, who lend themselves to reliable NPV valuations, would be expected to benefit from relatively modest IPO discounting, whereas NRCs at an earlier stage-of-development, especially exploration-focussed NRCs not anchored to any dependable valuation, would be predicted to involve heightened levels of IPO under-pricing.

To conclude the section, salient PVFs associated with the IPO process for the NRS include the finding that, during certain ‘hot’ markets, the IPOs of NRCs may be under-priced to an extraordinary degree. The extent of this under-pricing can be accentuated for particular equity markets (like the TSX-V), during bullish market conditions, for smaller companies with smaller IPO raisings, when IPO funds are raised with rapidity, and when there is - from a more theoretical standpoint - greater uncertainty concerning the post-listing price. There is mixed evidence concerning the potential for longer-run underperformance, although there is evidence that longer run performance is related to a NRC's stage-of-development.

4.4 The Value-relevance of SEOs

As the first capital raising to the public, an IPO signals a company's entry to the equity markets. For industrial firms with established earnings, there is typically only an infrequent need to tap the equity markets for additional funds following IPO, and thus, SEOs are a relatively rare occurrence. In contrast, for a NRC, the IPO is generally followed by frequent and regular SEOs. Most NRCs are at a pre-earnings development phase, and thus, are entirely dependent on the success of these SEOs. Given the capital intensity of the natural resources business, even the small minority of NRCs operating mines often require SEOs: either to fund mine expansions during favourable periods, such as those begot by higher commodity prices, or to bolster working capital and weather less favourable periods. Consequently, SEOs are crucial to the NRS. Yet, the importance of SEOs is not reflected in the literature, with very few studies examining SEOs as they specifically apply to the NRS. This section surveys generic findings from the SEO literature that might apply to the NRS, in addition to the SEO research, albeit limited, that specifically targets the NRS.

A principal finding from the generic SEO literature is that firms, by and large, issue new equity during periods of heightened market valuations – relative to historical market valuations and book value (Taggart, 1977; Marsh, 1982; Korajczyk, Lucas, & McDonald, 1991; Jung, Kim & Stulz, 1996 and Hovakimian, Opler & Titman, 2001). Indeed, a survey by Graham and Harvey (2001) found that CFOs, by their own admission, attempt to issue equity when they believe their stock is highly priced. By issuing equity when equity is valued highly, companies effectively lower their cost of capital. For a NRC seeking to develop a marginally economic project, lowering the cost of capital can be the difference between success and failure.

Issuing equity during periods of favourable market prices is the ultimate factor, according to Baker and Wurgler (2002) that produces capital structure. Indeed, Baker and Wurgler (2002, p.1), conclude that capital structure is, "the cumulative outcome of attempts to time the equity market.” More specifically, if previously issued equity was raised during periods of heightened market prices, the company will hold a relatively ‘tight’ capital structure (that is, have a small number of shares on issue), whereas, if previously issued equity was raised during periods of depressed market prices, the company will hold a relatively ‘diluted’ capital structure (that is, have a large number of shares on issue). Presumably, managers within the NRS will also seek to issue securities when their Company’s equity is highly priced. Nevertheless, without earnings and the luxury of time that earnings bestow, these managers, in a relatively large number of cases, may be forced to issue securities when prices are not favourable in order to fund the continued development of the company and, more pressingly, ward off insolvency. Nevertheless, the capital structure of any given NRC will be a product (Baker & Wurgler, 2002) of management’s success, or otherwise, at issuing equity during periods of heightened market prices.

Another significant generic finding to emerge from the literature concerns the under-pricing of SEOs. That is, as in the case of IPOs, SEOs tend to be priced below the market price, a fact first empirically confirmed by Smith (1977). Such under-pricing occurs despite the fact that, unlike IPOs, a market price is readily observable. Nevertheless, probably due to this existing market pricing, the under-pricing of SEOs is generally only a modicum of that observed in the IPO market. Notably, research confirms that SEO under-pricing is related to industry - for instance, research suggests that the SEOs of utility companies can actually command a premium to market prices (Bhagat & Frost, 1986; Eckbo & Masulis, 1992). Thus, there is the possibility that the NRS will be subject to industry-specific SEO pricing. The extent of SEO under-pricing has also been linked to stock exchange (Loderer, Sheehan, & Kadlec, 1991), whereby different stock exchanges exhibit different levels of SEO under-pricing. The value-relevance of stock exchange has already been verified for NRCs in the IPO arena: Smithson and Firer (2007) found differential under-pricing for new NRC listings on the AIM vis-à-vis the TSX-V.

SEO under-pricing, as in the case of IPOs, has also been related to information asymmetry. For instance, Bowen, Chen and Cheng (2008) investigated the role of investment analysts in reducing the costs of raising capital by mitigating information asymmetry. Based on 4,766 SEOs issued in the U.S. between 1984 and 2000, they found that increased analyst coverage tempers under-pricing. In addition, Bowen et al. (2008) found that the quality of the analysis was associated with reduced levels of under-pricing.

The NRS only receives limited and sporadic analyst coverage, which likely exacerbates the heightened levels of information asymmetry that characterises the sector. This heightened information asymmetry, in turn, likely intensifies SEO under-pricing in the NRS.

Another study by Corwin (2003), based upon a large sample of SEOs issued in the United States from 1980 to 1998, reported that the average level of SEO under-pricing had increased significantly over this period. Additionally, Corwin (2003) found that large SEOs relative to the size of the issuing firm (where, offer size = offered shares / shares outstanding prior to the offer), were associated with greater levels of under-pricing. The extent of the under-pricing was found to be exacerbated in stocks with inelastic demand - where low market capitalisation, low share price, high stock volatility and poor liquidity were employed as proxies for inelastic demand. Corwin (2003) argued that such a finding was due to transient pricing pressure: a large supply of new equity (large SEO) meeting relatively inelastic demand. Such a result is significant because relatively large SEOs, as well as the factors purportedly conducive of inelastic demand (low market capitalisation, low share price, high volatility, poor liquidity) - are all signature features of the NRS. Thus, SEOs in the NRS might be expected to involve exceptional levels of under-pricing.

In a more recent study into SEO under-pricing, capturing 1,840 SEOs issued between 2003 and 2011, Dempere (2011), reported a negative relationship between offer price and the extent of under-pricing. Such a result appears to be tautological, as, according to Dempere (2011, p.69), "the level of SEO under-pricing (UPi) is measured by the 1^{st}-day holding period return for SEO i, as $(P_1–P_0)/P_0$, where P_0 is the offer price and P_1 is the closing price of the day before the SEO date." Under this standard formulation, increasing the offer price (P_0) would, by definition, reduce the extent of under-pricing. Dempere (2011) found that the level of under-pricing increased over the sample period, rising incrementally over the 2003-2008 period, but leaping to unprecedented levels in the aftermath of the GFC – in 2009 the level of under-pricing approached 7.0 percent - more than double the levels of the pre-crisis period. Such a finding suggests the notion that macroeconomic conditions impact the SEO market.

The gradual, and then dramatic, increase in the average level of under-pricing documented by Dempere (2011) over the 2000s, forms an interesting point of comparison with the earlier work of Corwin (2003) – who, as previously mentioned, also documented a significant increase in the level of under-pricing over her study period which captured the 1980s and 1990s – confirming an increase in the level of SEO under-pricing for at least three decades. There are a number of reasons that have been put forward to explain this general rising trend in the level of SEO under-pricing. One potential reason posits a fundamental change in the constitution of the economy – namely that firms whose fundamental business is more intrinsically uncertain (for instance, information technology, fashion) have grown in importance relative to more traditional firms less beset by uncertainty (for instance, insurance, manufacturing). Predicting how investment translates to future cash flows is a much more difficult task in the former case given the increased uncertainty – and this increased uncertainty may explain the increasing trend towards larger SEO discounts. Assuming uncertainty is the root cause of SEO under-pricing, it might be expected that SEO under-pricing within the NRS would have remained constant over time – given the truism that immense levels of uncertainty have always characterised the NRS.

Yet another generic finding from the SEO literature is that SEOs typically usher in a period of long-run underperformance (Spiess & Affleck-Graves, 1995; Jegadeesh, 2000; Brown, Gallery & Goei, 2006). Despite being challenged by several studies (including Bayless and Jay, 2003); Brav, Geczy and Gompers (2000), the dominant position of current research is that SEOs do indeed prompt long-run underperformance (Bowen et al., 2008; Billett, Flannery & Garfinkel, 2011); Carpentier, L'Her & Suret, 2012).

Carlson, Fisher, and Giammarino (2006) explain SEO underperformance from a rational real options perspective. In particular, Carlson et al. (2006) suggest that capital raisings enable firms to exercise real options. Consequently, risky options are converted into less risky assets, thereby unlocking latent value while reducing the overall risk of the firm. Carlson et al. (2006) argues that this overall risk reduction elicits the subpar returns generally observed following SEOs.

In a similar vein, Eckbo, Masulis, and Norli (2000) argue that the observed under-performance is a logical outcome, given that SEOs reduce: leverage, insolvency risk and unexpected inflation exposure – all of which acts to reduce expected returns. Still, such generic findings may not apply to the NRS. In particular, the NRS is deeply imbued with uncertainty to the point of saturation, such that, the statistical likelihood is, despite the NRC's best efforts, eventual insolvency. Thus, the order of uncertainty involved in the

NRS is so much greater than the broader market that SEOs may not, in general, usher in a period of long-run underperformance. Rather, any such reduction in uncertainty for the archetypal NRC may not – as is the case for the broader market – lead to long-run under-performance. In fact, there is evidence to suggest that long-term underperformance in the wake of SEOs may not be as pronounced for the NRS. In particular, Brown, Ferguson, and Stone (2008) empirically investigated a special form of SEO, share purchase plans, on the ASX, finding that mining35 companies did not underperform to the extent of other sectors.

Prevailing macroeconomic conditions, as in the case of IPOs, is also supported in the literature as influential to the SEO market. Erel, Julio, Kim and Weisbach (2011) employed a large sample of SEOs and debt issues, in the U.S. from 1971 to 2007 to investigate the impact of macroeconomic conditions. Their findings supported the important influence of macroeconomic conditions on the capacity of firms to conduct SEOs. Amongst other findings they report that, for non-investment grade borrowers - like the NRS - SEOs typically flourish during economic upturns but languish during economic downturns.

As previously emphasised, any non-sector specific findings must be treated with caution when applied to the highly idiosyncratic NRS. Unfortunately there is a relative dearth of research examining SEOs from the perspective of NRCs as compared to IPOs. A notable exception is Cranstoun (2010), who tested the value-relevance of capital raisings to gold companies with market valuations of between $100 and $800 million listed on major U.S. and Canadian Exchanges from Aug/08 to Mar/10. This yielded a sample of 42 public and 59 private capital transactions. The study tested a number of PVFs, including the extent of dilution, prior stock performance, whether warrants were also issued and whether the company held producing facilities. Nevertheless, none of the PVFs tested were found to be significant. Cranstoun (2010) asserts that this may be a result of the underlying small sample size and because capital raisings are associated with factors expected to depress price (for example, dilution), as well as factors expected to increase price (for example, moving closer towards development), with potentially little net impact[36]. The validity of the Cranstoun (2010) study may also have been hampered by

[35] Where *mining* companies denote materials and energy companies - as defined under the GICS classification system.

[36] Although regression analysis is supposed to control for such effects.

the time period over which the study's dependent variable (share price performance) was measured: share price performance on the day prior to the announced capital raising was compared to the share price on the day of the announced capital raising. Such a constricted event window presupposes a market perfectly free from insider trading, which runs counter to available empirical research that suggests that insider trading is relatively rampant within the NRS (as evidenced by Bird et al., 2013). Due to the potential for insider trading, the PVFs assessed by Cranstoun (2010) may have been largely priced in by the market on the day prior the capital raising announcement – and thus, the study may have missed the import of these factors.

One of the PVFs tested by Cranstoun (2010) - that is most often cited in the literature as of value-relevance - is dilution. While some level of dilution is inevitable in any equity issue, there is literature suggesting that excessive dilution is detrimental to building wealth within the NRS. In particular, a SEO involves a treacherous trade-off: balancing, an often dire, need to raise funds to advance the business, while attempting to avoid the excessive dilution of existing shareholders - who might be unable to participate in the current offer. Existing shareholders are effectively disenfranchised if they are unable to participate in the current offer - as their proportional ownership of the company is eroded. Moreover, excessive dilution risks off-siding existing shareholders whose support might be required in future capital raisings. Nevertheless, according to some authorities, the deleterious impact of dilution is overstated when applied to the NRS - quoting the AMEC (Bennison, 2012, p.2):

> "Given that buying shares in exploration companies are often speculative investments where investors only buy shares in the hope of success in the future, the shareholders of exploration companies are the least likely type of shareholder to have an issue in the event that their investments are diluted. This is because there is no dividend income that would have to be shared among the additional shareholders."

Thus, fears of dilution must be tempered by due consideration to other risks, particularly, that a NRC, unable to raise fund through a SEO, might be rendered insolvent.

In summary, PVFs associated with SEOs that may influence NRCs include the finding that SEOs are generally issued during periods of heightened market prices and that the SEO itself is generally under-priced. The under-pricing of SEOs is expected to be especially acute in the NRS – with larger SEOs associated with greater levels of under-pricing. Furthermore, SEOs are generally harbingers of long-run underperformance – although there is reason to expect that any such underperformance will be mollified in the case of NRCs. Macroeconomic conditions are also deemed an important factor influencing SEOs - with the expectation that the NRS will undertake more SEOs during buoyant market conditions. Meanwhile, evidence concerning the relationship between the dilutionary impact of SEOs and market prices remains mixed.

4.5 Data, Data Processing and Statistical Analyses

The aim of this section is to empirically examine how capital raisings, and PVFs related to capital raisings, affect the market's valuation of NRCs. The preceding literature review highlighted the paucity of research into SEOs relative to IPOs. This suggests that SEO-focussed research, as opposed to IPO-focussed research, holds, in a research sense, more potential to 'add-value'. Consequently, the empirical analysis to follow is exclusively based upon SEOs.

4.5.1 Event Study Methodology

A SEO can be conceptualised as an event in time. Thus, the aim of this section is to determine if this event - the SEO - influences the market's valuation a NRCs undertaking the SEO. Accordingly, an event study is adopted as an appropriate research design to conduct the analysis. In general, SEOs are usually triggered when a company announces its intention to raise funds (the start-date) and finalised when these funds, or some portion thereof, are raised (the end-date).

To conduct an event study - an 'event window' – the period of time over which the effect of the event is assessed - needs to be designated. For the purposes of this research the event window will capture both the period preceding the start-date as well as the period following the end-date. Specifically, the event window herein includes the 90 days preceding the start-date and the start-date itself, and, further, the 90 days following the end-date and the end-date itself. Thus, in total, the event window captures a total of 182 days (130 trading days) surrounding the SEO.[37] Such a multi-month event window is considered a sufficient period of time to capture the impact of SEOs on the market value of NRCs. Indeed, this event window exceeds by some multiples the extant research into the NRS employing the event study methodology, namely: Lawritsen (1993) tested a 40 day event window, Bird et al. (2013) adopted an event window of 31 days, whereas Pündrich (2014) selected an event window of 21 days. Still, there may be longer-term effects associated with the capital raisings that would require a longer event window to

[37] Specifically, 90+1+90+1.

assess – such a possibility is left as an avenue for future research. Another limitation of such an event window is that the period of time between the start-date and end-date, which is variable and depends on the specific SEO under consideration, is excluded from the analysis. Again, potential pricing patterns occurring between the start-date and end-dates of an SEO is left to future research.

In general terms, event studies assess the impact of an event based upon share price returns for companies directly impacted by that event relative to some benchmark. Therefore, in order to judge if companies impacted by an event are experiencing abnormal returns, different event study methodologies usually employ different benchmarks. This research employs a methodology originally developed by Barber and Lyon (1997) in which companies experiencing an event are matched to a company with similar characteristics that serves as the benchmark to judge whether returns are abnormal. A recent example of empirical research in the NRS employing such a methodology is Bird et al. (2013).[38] Under this approach, the abnormal returns (ar_{it}) accruing to a stock i on day t experiencing the event is determined by deducting the returns of a matched stock (r_{mt}) from the returns of the event study stock (r_{it}) for that day.

$$ar_{it} = r_{it} - r_{mt}$$

The next step under this methodology involves calculating the average abnormal return (ARR_t). This is calculated as the summation of all abnormal returns and then dividing by the number of companies experiencing the event (n) for each day t over the event window as per the equation:

$$ARR_t = 1/n\, \Sigma_{i=1}^{n} ar_{it}$$

Finally, the cumulative average abnormal return (CAR), commencing on day q and concluding on day s, is found by summing each ARR_t from q to s:

$$CAR_{q,s} = \Sigma_{t=q}^{s} ARR_t$$

Accordingly, for the analysis herein, a sample of NRCs conducting SEOs is drawn from the Intierra (2011) dataset. The share price returns of these NRCs conducting SEOs are calculated over the event window, namely, for the 90 days preceding the SEO's start-date plus the start-date itself, as well as for the 90 days following the SEO's end-date plus

[38] The findings from Bird et al. (2013) are discussed in detail in subsequent chapters.

the end-date itself. Next, a matching NRC is identified: this matched company is drawn from the master list of NRCs and is that company holding the nearest market capitalisation to the NRC conducting the SEO. The share price returns for this matched NRC are then determined over the event window. Finally, abnormal returns are calculated by subtracting the returns of this matched NRC from the returns of the NRC conducting the SEO. Similarly, average abnormal returns and CARs are calculated via the above equations. Thus, the first step in this research design is to locate a sample of NRCs undertaking SEOs. The method by which this sample was obtained is the subject of the next section.

4.5.2 Refining the Sample and Identifying Matching Companies

The dataset sourced from Intierra (2011) comprised 2,332 capital raisings conducted by companies, from across the globe, involved in the natural resources industry from 2009 to 2011 inclusive. The process by which this sample was refined in order to produce the final sample on which the analysis is conducted is described presently.

Firstly, the companies conducting the capital raisings were cross-referenced against the master sample to ensure that the companies in the final sample constituted NRCs as defined under this research: members of the top 16 stock exchanges for the NRS and classified as either producers or explorers as of December 2011. This resulted in 166 capital raisings being culled from the sample. Next, IPOs were excluded from the sample given the decision to focus solely on the under-researched domain of SEOs. As a result, the 313 IPOs in the sample were removed. In addition, any NRCs with market capitalisations exceeding US$1.5 billion were excluded from the sample. There were 37 SEOs that were consequently struck from the sample given that the issuing NRC's market capitalisation exceeded the US$1.5 billion limit.[39] Finally, a liquidity requirement was imposed for companies to be included in the final sample. Bird et al. (2013) employed such a requirement, where companies not trading for at least 50 percent of the trading days of the event window excluded. In keeping with this approach, the same 50 percent liquidity requirement was adopted – where NRCs not trading for at least 50 percent of the available trading days removed from the sample.[40] Under this filter, the sample was

[39] The methodology under which market capitalisation is determined is discussed in the following paragraph.

[40] For the 182 days of the event window, 130 (182*5/7) are trading days. Thus, where a company did not trade at least 65 days (130*.5), it was removed from the sample.

reduced by a further 290 SEOs. Having refined the sample thus, the sample was reduced from the original 2,332 capital raisings to 1,526 SEOs.

As noted, the sample of 1,526 SEOs were all conducted by NRCs who are members of the master-sample. The next step in the research design involved calculating the market capitalisation for each company in the master-sample on a quarterly basis (namely, for 31/March, 30/June, 30/September, 31 December - beginning with Dec/08 - for 2009, 2010 and 2011 inclusive). Specifically, market capitalisation was calculated as the product of the number of shares and share price. Data for the number of shares and share price was sourced from Thomson Reuters Tick History (2014). In particular, the number of shares was taken to be the latest reported number of shares from the Thomson Reuters database from the end-date of the quarter through the preceding 90 days. To calculate share price, the daily VWAPs were averaged for the 30 days prior to the end-date of the quarter, the 30 days following the end-date of the quarter, and the end-date of the quarter itself (61 day series). Thus, the market capitalisation for the 2,609 in the master-sample were calculated on a quarterly basis. The start-date for each SEO in the sample was than matched to the closest quarter, and the market capitalisation for the NRC as calculated at that quarter was taken to be the market capitalisation for the NRC conducting the SEO. Finally, the market capitalisation of the NRC conducting the SEO was matched to the NRC holding the closest market capitalisation for the relevant quarter. This NRC, holding the closest market capitalisation to the NRC conducting the SEO, was taken to be the matching NRC. In this manner, the matching NRCs were sourced.

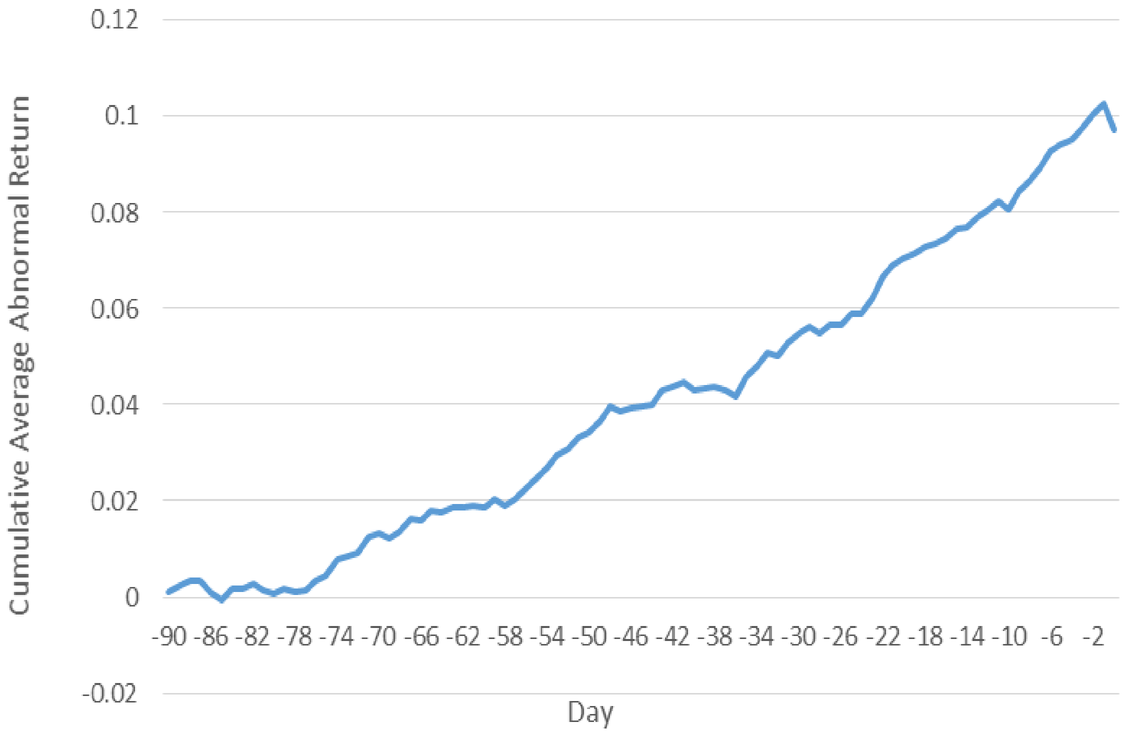
Having sourced the underlying sample of NRCs conducting SEOs, in addition to their matching NRCs, abnormal returns, average abnormal returns and CARs could be calculated. However, upon calculation, the average and cumulate abnormal returns were found to exhibit extreme volatility and the source of this volatility was apparently random. Further investigation revealed that this volatility was due to outliers in the data where an underlying NRC's VWAP for a given day multiplied many times or dropped to only a fraction of the previous day's price. These dramatic changes in price constituted only a tiny fraction of the total price data, but their presence was enough to drastically alter the average and cumulative abnormal returns on certain randomly dispersed days across the event window. That such extreme volatility exists is a well-known characteristic of the NRS – however, this extreme volatility clouded attempts herein to isolate the potential impact of capital raisings on market value. Consequently, it was decided to filter out such outliers in the abnormal returns by nullifying any daily return greater than ±50 percent by changing any such value to 0 percent. Having filtered out these outliers the average and cumulate abnormal returns were made much smoother and statistical results were consequently obtained. These results will be discussed in the next section.

4.5.3 Pricing Patterns around SEOs

The literature review identified two chief price patterns associated with SEOs, namely (1) new equity is generally issued during heightened market valuation and, (2) SEOs typically usher in a period of long-run underperformance. The analysis will thus test both these observations to determine if they apply to the NRS.

Diagrammatically, the resulting CARs are now presented. Figure 44 shows CARs for the 90 days preceding (-90 to -1) the start-date of the SEO plus the start-date (0) itself.

Figure 44 - Cumulative average abnormal returns pre-SEO



Meanwhile, Figure 45 illustrates CARs for the 90 days following (1 to 90) the end-date of the SEO plus the end-date (0) itself.

Figure 45 - Cumulative average abnormal returns post-SEO

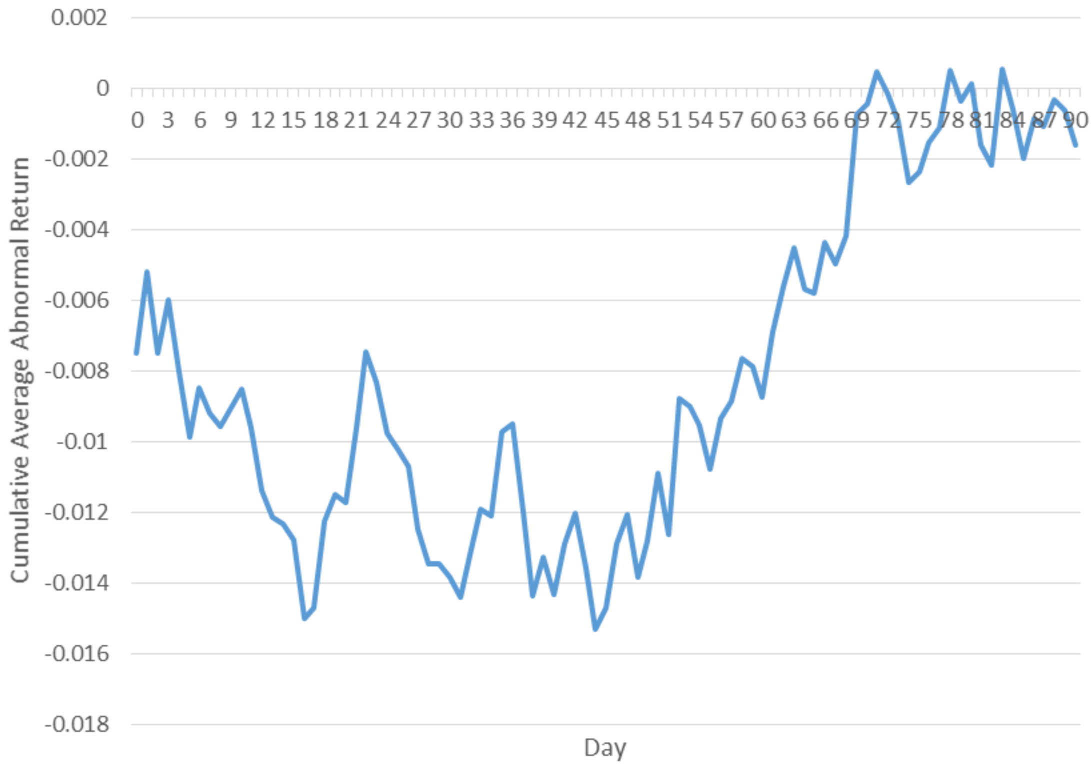


Figure 44 suggests that the share price returns of NRCs are indeed abnormal for the period preceding the release of a SEO: the CAR increases by approximately 10% in the 90 days preceding an SEO. This suggests that the literature's contention that SEOs are generally issued during periods of heightened market valuation holds for NRCs. By contrast, for the 90 day period following the end-date of SEOs within the NRS, as represented by Figure 45, there appears to be little net effect.

The next section involves formal statistical analysis to confirm the intuitions gleaned from the preceding two diagrams.

4.5.4 Formal Statistical Analysis of Pricing Patterns around SEOs

Following the work of Ritter (1991), the CAR t-statistic is calculated as:

$$\text{CAR } t\text{-statistic} = CAR_{q,s} \times \sqrt{N_t} \ / \ \{[(q-s) \times \text{var} + 2 \times ((q-s) - 1) \times \text{cov}]\text{\^{}}1/2\}$$

Where, $CAR_{q,s}$ - commencing on day q and concluding on day s - is found by summing each ARR_t from day q to day s. Similarly, q-s is simply the number of days from day s to day q. N_t represents the number of abnormal returns observed (namely, 1,526). Var is the average cross-sectional variance from day q to day s. Cov is the first-order co-variance of the abnormal returns from day q to day s.

Calculating this t-statistic for the period from the 90 days before the SEO start-date to the start date itself (q=-90 to s =0) yields a value of 6.19. This corresponds to a p-value of less than 0.0001, thus, the positive abnormal returns accruing during the lead-up of the SEOs start-date is deemed a statistically significant phenomenon. Likewise, calculating the t-statistic from the end-date of the SEO until 90 days thereafter (1=0, s=90) yields a value of -0.14. This corresponds to a p-value of 0.98 – thus, the share price returns in the several months following an SEO end-date are not considered, at least over this time-period, to be abnormal.

4.5.5 Variable Definition and Multiple Regression

The analysis thus far has confirmed, for the specialised NRS, the generic literature's finding that SEOs are usually issued during periods of heightened market valuation. This suggests that NRCs are opportunistic: when the market valuation of a NRC outperforms that company is much more likely to undertake a SEO. That is, it appears likely that that SEOs does not cause the run-up in market prices but rather, that the run-up in market prices causes the SEO. By contrast, the generic literature's finding that the period following SEO's are typically conducive of abnormally negative returns failed to replicate for this sample – at least for the several months following the SEOs. Multiple regression analysis will now be conducted to help discover how other factors related to capital raisings and suggested by the literature might influence these general patterns. Thus, a number of PVFs related to capital raisings are tested against the CARs for the 90 days preceding and including the start-date of SEOs, as well as for the 90 days following and including the end-date of SEOs.

Notably, even though the foregoing analysis did not suggest that the period following the capital raising end-date was related to any abnormal returns, abnormal returns may still exist here. In particular, some of the PVFs being investigated might demarcate a sub-sample which does either out-perform or under-perform post the SEO close-date. Likewise, there may be little net-effect post the SEO end-date as some NRCs experience abnormally positive returns while others experience abnormal returns and – whether a NRC is likely to experience one or the other might be related to some of the PVFs to be tested. In particular, the literature review identified a number of PVFs that may impact market pricing during capital raisings. Specifically, the literature review identified the following PVFs:

1. Size of the capital raising.
2. Size of the capital raising relative to the size of the company.
3. How quickly the capital is placed.
4. Macroeconomic conditions.
5. Exchange.
6. Uncertainty concerning the post-issue price, as proxied by:
    i. Market capitalisation,
    ii. Share price,
    iii. Share price volatility,
    iv. Liquidity,
    v. Stage-of-development, and
    vi. Underwriters accepting options.

These PVFs were identified by both the IPO and SEO literature – thus, although the empirical research to follow is focussed solely upon SEOs, both the IPO and the SEO literature is drawn upon to identify potential PVFs.

The metrics under which these variables are represented are discussed presently, with those variables that serve as a proxy for uncertainty discussed first. Market capitalisation was calculated by multiplying the number of shares and share price. Data for the number of shares and share price were both sourced from Thomson Reuters Tick History (2014). To calculate share price, the daily VWAPs were averaged for the 61 day series commencing 30 days prior to the start date through to 30 days after the start date (including the start date itself). It was considered appropriate to average VWAPs over several months to ensure that this point estimate really represented the best 'average' share price for such often volatile and illiquid firms. Notably, this share price also served to represent the share price variable. The number of shares was taken to be the latest reported number of shares from 91 days before the SEO start date until 456 days (one year) before the SEO start date. Such a lengthy time period was necessary to ensure that the number of shares was captured for every companies in the sample, given that the Thomson Reuters data only notes the number of shares on those dates when the number of shares actually changed. Share price volatility was calculated as the standard deviation in daily VWAPs over the same 61 days series used to calculate the share price (that is, from 91 days before the SEO start-date until 180 days before the SEO start-date). The daily volume were summed over this same 61 day series and multiplied by share price to assess turnover in a stock – this variable serving as a proxy for liquidity and representing that variable. Furthermore, the Intierra data (2011) notes how the capital raised is to be spent—e.g. 1) development, 2) asset acquisition, 3) exploration, 4) corporate acquisition/merger, 5) capital expenditure, 6) working capital and 7) other. This nominal variable was selected to proxy for the variable of stage-of-development. The final variable suggested by the literature to represent potential uncertainty was whether or not underwriters accepted options as part of the raising, unfortunately, information concerning this variable could not be obtained and so this variable was not included in the analysis.

The size of the capital raising was represented by the amount raised under the SEO at completion of the capital raising (this variable is hereafter referred to as 'size'). Size of the capital raising relative to the size of the company is represented as a ratio of the size variable to market capitalisation (this variable is hereafter referred to as 'SizeToMC'). To measure how quickly the capital is placed the number of days from the start-date of the SEO until the close-date was employed. To capture macroeconomic conditions the CINRS was employed. Specifically, the month in which the start-date of the SEO occurred was taken to the month at which the CINRS was referenced.41 Finally, stock exchange was a nominal variable representing the stock exchange upon which the SEO was undertaken – this information was procured as part of the Intierra (2011) database.

In prelude to the regression analysis to follow, descriptive statistics are presented for the dataset in Table 14 below.

[41] The CI_{NRS} is a monthly index.

Table 14 - Descriptive Statistics

```
     Code       Exchange      Macro            Size               Speed
 GOA.AX :   6   ALT:  8   Min.   :1.929   Min.   :    484613   Min.   :  1.00
 MOY.AX :   6   ASE:  4   1st Qu.:2.096   1st Qu.:  3244461   1st Qu.: 15.00
 VGQ.TO :   6   ASX:638   Median :2.282   Median :  6000000   Median : 27.00
 YNG.TO :   6   CNQ:  2   Mean   :2.237   Mean   : 17189700   Mean   : 38.43
 CUU.V  :   5   OTC:  4   3rd Qu.:2.388   3rd Qu.: 15358730   3rd Qu.: 44.75
 MNC.AX :   5   TSE:253   Max.   :2.428   Max.   :500000000   Max.   :549.00
 (Other):1492   TSX:617
                Activity      SharePrice            MC
 Exploration        :840   Min.   : 0.003409   Min.   :     150
 Development        :364   1st Qu.: 0.135603   1st Qu.:   13078
 Working Capital    :106   Median : 0.284935   Median :   30229
 Asset Acquisition  : 85   Mean   : 0.774718   Mean   :  108721
 Capital Expenditure: 68   3rd Qu.: 0.713045   3rd Qu.:   82993
 Other              : 31   Max.   :30.460790   Max.   :10074840
 (Other)            : 32
   Liquidity            StdDev            SizeToMC           CAR_Before
 Min.   :1.244e+04   Min.   :0.0004171   Min.   : 0.001693   Min.   :-2.55051
 1st Qu.:1.129e+06   1st Qu.:0.0159254   1st Qu.: 0.120707   1st Qu.:-0.22437
 Median :3.530e+06   Median :0.0346658   Median : 0.236689   Median : 0.08879
 Mean   :2.126e+07   Mean   :0.0938755   Mean   : 0.409581   Mean   : 0.09715
 3rd Qu.:1.208e+07   3rd Qu.:0.0897121   3rd Qu.: 0.440065   3rd Qu.: 0.42140
 Max.   :1.231e+09   Max.   :2.3977196   Max.   :14.209645   Max.   : 1.88349

   CAR_After
 Min.   :-3.033815
 1st Qu.:-0.284874
 Median :-0.012764
 Mean   :-0.001635
 3rd Qu.: 0.283181
 Max.   : 1.825006
```

In complement to the descriptive statistics provided in Table 14, the correlation matrix is presented in Table 15. It is noted that in general, only moderate levels of collinearity exist between the independent variables.

Table 15 - Pearson Correlation Results

	Macro	Size	Speed	SharePrice	MC	Liquidity	StdDev	SizeToMC
Macro	1.000000000	0.009944003	-0.14333998	0.05121440	0.01642878	0.05915110	0.07298966	-0.03893004
Size	0.009944003	1.000000000	0.05278068	0.30787335	0.26064777	0.37037798	0.30179204	0.09638125
Speed	-0.143339980	0.052780678	1.00000000	-0.07175379	0.01417354	0.01788786	-0.06676270	0.13415189
SharePrice	0.051214401	0.307873349	-0.07175379	1.00000000	0.65576213	0.44670586	0.81950910	-0.12404658
MC	0.016428782	0.260647774	0.01417354	0.65576213	1.00000000	0.63547662	0.56698978	-0.09480692
Liquidity	0.059151098	0.370377982	0.01788786	0.44670586	0.63547662	1.00000000	0.48771579	-0.09828821
StdDev	0.072989657	0.301792037	-0.06676270	0.81950910	0.56698978	0.48771579	1.00000000	-0.11062922
SizeToMC	-0.038930038	0.096381252	0.13415189	-0.12404658	-0.09480692	-0.09828821	-0.11062922	1.00000000

The code employed to conduct the multiple regression analysis is recorded by Insert 8 of Appendix B. The results of the regression analysis of the CARs, for the pre-SEO and post-SEO periods are presented in Table 16 and Table 17, respectively.

Table 16 - Regression analysis of returns for pre-SEO period

```
Call:
lm(formula = CAR_Before ~ Macro + Exchange + Size + SizeToMC +
    Speed + MC + SharePrice + StdDev + Liquidity + Activity)

Residuals:
    Min      1Q  Median      3Q     Max
-2.6512 -0.3122  0.0020  0.3235  1.7322

Coefficients:
                                      Estimate Std. Error t value Pr(>|t|)
(Intercept)                         -2.715e-01  3.515e-01  -0.773   0.4399
Macro                                7.424e-02  9.605e-02   0.773   0.4397
ExchangeASE                          2.653e-01  3.888e-01   0.682   0.4950
ExchangeASX                          1.513e-01  2.823e-01   0.536   0.5922
ExchangeCNQ                          8.255e-02  4.739e-01   0.174   0.8617
ExchangeOTC                          1.490e-01  3.902e-01   0.382   0.7026
ExchangeTSE                          1.349e-01  2.806e-01   0.481   0.6309
ExchangeTSX                          1.289e-01  2.827e-01   0.456   0.6484
Size                                -2.249e-10  4.999e-10  -0.450   0.6529
SizeToMC                             1.332e-01  1.921e-02   6.933 6.09e-12 ***
Speed                               -2.179e-04  3.088e-04  -0.706   0.4805
MC                                   6.490e-08  6.934e-08   0.936   0.3494
SharePrice                          -1.266e-02  1.663e-02  -0.761   0.4468
StdDev                               1.178e-01  1.321e-01   0.892   0.3723
Liquidity                           -6.695e-10  2.731e-10  -2.452   0.0143 *
ActivityCapital Expenditure         -1.172e-01  9.086e-02  -1.290   0.1972
ActivityCorporate Acquisition/Merger  1.113e-01  3.163e-01   0.352   0.7249
ActivityDebt Reduction/Rollover     -9.710e-02  1.170e-01  -0.830   0.4069
ActivityDevelopment                  3.042e-02  6.586e-02   0.462   0.6442
ActivityExploration                  4.061e-02  6.219e-02   0.653   0.5139
ActivityOther                       -1.927e-02  1.141e-01  -0.169   0.8660
ActivityWorking Capital              7.017e-02  7.906e-02   0.888   0.3749
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.5356 on 1504 degrees of freedom
Multiple R-squared:  0.04709, Adjusted R-squared:  0.03378
F-statistic: 3.539 on 21 and 1504 DF,  p-value: 1.155e-07
```

Table 17 - Regression analysis of returns for post-SEO period

```
Call:
lm(formula = CAR_After ~ Macro + Exchange + Size + SizeToMC +
    Speed + MC + SharePrice + StdDev + Liquidity + Activity)

Residuals:
     Min       1Q   Median       3Q      Max
-1.80478 -0.28494 -0.00774  0.28097  1.85603

Coefficients:
                                      Estimate Std. Error t value Pr(>|t|)
(Intercept)                         -2.783e-01  3.082e-01  -0.903  0.36672
Macro                               -4.729e-02  8.424e-02  -0.561  0.57463
ExchangeASE                          4.334e-01  3.409e-01   1.271  0.20381
ExchangeASX                          3.902e-01  2.476e-01   1.576  0.11526
ExchangeCNQ                         -1.098e+00  4.156e-01  -2.642  0.00832 **
ExchangeOTC                          7.836e-01  3.422e-01   2.290  0.02215 *
ExchangeTSE                          3.991e-01  2.461e-01   1.622  0.10511
ExchangeTSX                          4.084e-01  2.479e-01   1.648  0.09964 .
Size                                -1.524e-10  4.384e-10  -0.348  0.72809
SizeToMC                             2.911e-02  1.685e-02   1.728  0.08422 .
Speed                                2.684e-04  2.708e-04   0.991  0.32179
MC                                   7.601e-08  6.081e-08   1.250  0.21149
SharePrice                          -7.905e-03  1.459e-02  -0.542  0.58795
StdDev                               2.656e-02  1.158e-01   0.229  0.81865
Liquidity                           -1.474e-10  2.395e-10  -0.615  0.53846
ActivityCapital Expenditure         -2.504e-02  7.968e-02  -0.314  0.75339
ActivityCorporate Acquisition/Merger -1.436e-01  2.774e-01  -0.518  0.60472
ActivityDebt Reduction/Rollover      5.820e-02  1.026e-01   0.567  0.57076
ActivityDevelopment                 -6.232e-02  5.776e-02  -1.079  0.28076
ActivityExploration                 -3.977e-02  5.454e-02  -0.729  0.46594
ActivityOther                        1.434e-02  1.001e-01   0.143  0.88611
ActivityWorking Capital              2.766e-02  6.933e-02   0.399  0.69002
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.4697 on 1504 degrees of freedom
Multiple R-squared:  0.02394, Adjusted R-squared:  0.01031
F-statistic: 1.757 on 21 and 1504 DF,  p-value: 0.01834
```

Thus, for the period leading up to the SEO's start-date, abnormal returns are positively related to the size of the SEO relative to the NRC's market capitalisation, and negatively correlated to liquidity (as proxied by turnover). For the period following the SEO end-date there is some evidence exchange might be of some significance. Meanwhile, there is weaker evidence (at a 10 percent significance level) that the size of the capital raising relative to the market capitalisation of the company may again be positively related to abnormal returns.

4.5.6 Section Summary

This section comprised statistical analysis of SEOs as they apply to the NRS. First, the general structure of the analysis undertaken, an event study methodology, was discussed. Furthermore, the sampling method was explained. Under the methodology adopted each NRC conducting a SEO in the sample was matched to another NRC and the system by which this matching process occurred was described. Subsequently, CARs were calculated from 90 days prior to the announcement of an SEO through to 90 days after with the results expressed diagrammatically. Formal statistical analysis of the pricing patterns observed in these diagrams was then conducted. It was found that the positive CARs observed in the 90 days leading up to the announcement of an SEO were highly significant whereas the pricing patterns observed after the announcement were not significant. To provide more insight into these results PVFs associated with SEOs were then related, under multiple regression analysis, to the CARs. CARs, for the period prior to the announcement of a SEO, were found to be positively related to the size of the SEO relative to the size of the issuing NRC but negatively related to liquidity. Meanwhile, CARs, for the period following the announcement of a SEO, were found to be significantly related to certain stock exchanges and again, although at a weaker significance level, positively related to the size of the SEO relative to the NRC's size.

4.6 Chapter Summary

This Chapter first considered the role of capital raisings within the NRS and then PVFs associated with, in turn, IPOs and SEOs. It was noted in passing that there is a paucity of research into SEOs, as compared to IPOs, when it comes to the NRS-specific literature. To help remedy the situation statistical analysis, under an event study methodology, was conducted examining SEOs within the NRS. The findings of this analysis revealed that the share price performance of NRCs, in the months leading-up to a SEO, are generally marked by significant and positive CARs. One potential explanation for this finding is that company directors are ‘timing’ capital raisings to occur at more favourable prices to maximise shareholder participation and minimise dilution. An alternative explanation is that company directors, knowing that they need to raise capital, are ‘engineering’ a temporary share price appreciation to maximise the SEO’s chances of success. In fact, the regression results indicate that illiquid companies are more likely to exhibit significant and positive CARs in the period preceding a SEO, adding credence to the hypothesis that directors may be engineering temporary share price appreciations. An even stronger result to emerge from the regression analysis was that the larger the capital raising with respect to the company’s market capitalisation, then the greater the pre-SEO share price outperformance. The size of a capital raising with respect to the size of the company may proxy for the relative ‘importance’ of the capital raising to the company. If so, it suggests that more important capital raisings may encourage directors to either time SEOs better or, alternatively, employ artifice to facilitate share price outperformance prior to the SEO.

This Chapter has explored the relationship between market value and capital raisings insofar as the NRS is concerned. Ultimately, the purpose of capital raisings is to advance NRC’s to their next stage-of-development: from explorer, to developer and finally, miner. As such, stage-of-development forms the subject of the succeeding Chapter.

Chapter 5: Stage-of-Development Factors

5.1 Chapter Introduction

Capital raisings and stage-of-development are intimately connected; specifically, capital raisings are necessary for a NRC to garner the funds needed to advance its projects through the various stages-of-development: from exploration to productive mine. The monies raised under capital raisings being ultimately intended, after overheads and administrative costs, to be spent in the ground through such activities as proving up exploration concepts and advancing mine development across the NRC's suite of projects. In fact, a NRC's overall stage-of-development is generally considered a function of the stage-of-development of its underlying projects. Indeed, a NRC's stated stage-of-development usually corresponds to the stage-of-development of its most advanced project – the Company's 'flagship'.

Accordingly, a NRC's stage-of-development is a function of the stage-of-development of its underlying projects. Typically, a NRC maintains a portfolio of projects, with only minority at a relatively advanced stage-of-development. In the Australian context, Kreuzer et al. (2007) reported that the typical NRC débuted on the ASX with five projects, most of which were at an early grass-roots stage-of-development, although there was usually one flagship project with targets awaiting drill testing within the first year of listing. NRCs adopt such a portfolio approach to mitigate the high levels of uncertainty involved in their business model; advancing multiple projects concurrently until a project elicits positive results or gains traction in the marketplace. It is typical then for a NRC's portfolio to hold only one to a few advanced projects; and a larger number of nascent projects.

In general, NRCs at more advanced stages-of-development are associated with higher market valuations and so, stage-of-development is considered an important PVF. Given that the nature of the NRS is akin to venture capital, the significance of stage-of-development is emphasised by Czernkowski and Ferguson (2006, p.3):

> "One of the chief characteristics of informationally deficient markets such as the extractive industry is that the relevance of conventional signals, such as earnings announcements, is less significant than in other industries. One reason for this is that, with single project or single resource companies, the predictive ability of earnings numbers is much less. The firm's failure risk is comparatively high, and is keyed not so much to the quality of earnings (indeed, there may be no earnings), but more to the geological and pricing conditions in the resource market in which it operates. Accordingly, the signals that are hypothesised to carry much more weight are those signals which indicate the extent of progress or milestone completion through the exploration/development life cycle."

Thus, a NRC's stage-of-development is deemed an important PVF. More specifically, stage-of-development is an important PVF because it informs both the: 1) magnitude and timing of cash flows, and 2) uncertainties and risks associated with those cash flows. These two elements are discussed in turn.

5.2 The Magnitude and Timing of Future Cash Flows

A basic precept of finance is that the value of any asset is a function of its future cash flows, adjusted for the uncertainties associated with those cash flows. Specifically, the hope of production and the promise of the associated earnings is the motivating force of the NRS. In particular, market value is based upon the expectations of future cash flows, and these expectations crystallise as a NRC approaches to production.

Production, in many ways, at least from an investment standpoint, represents the crowning stage-of-development. Nonetheless, every stage-of-development holds value-relevance to a NRC. Indeed, stage-of-development powerfully mediates which PVFs hold relevance. Kennedy (1996, p.283), for instance, in constructing a framework of performance drivers for newly listed NRCs, reported that:

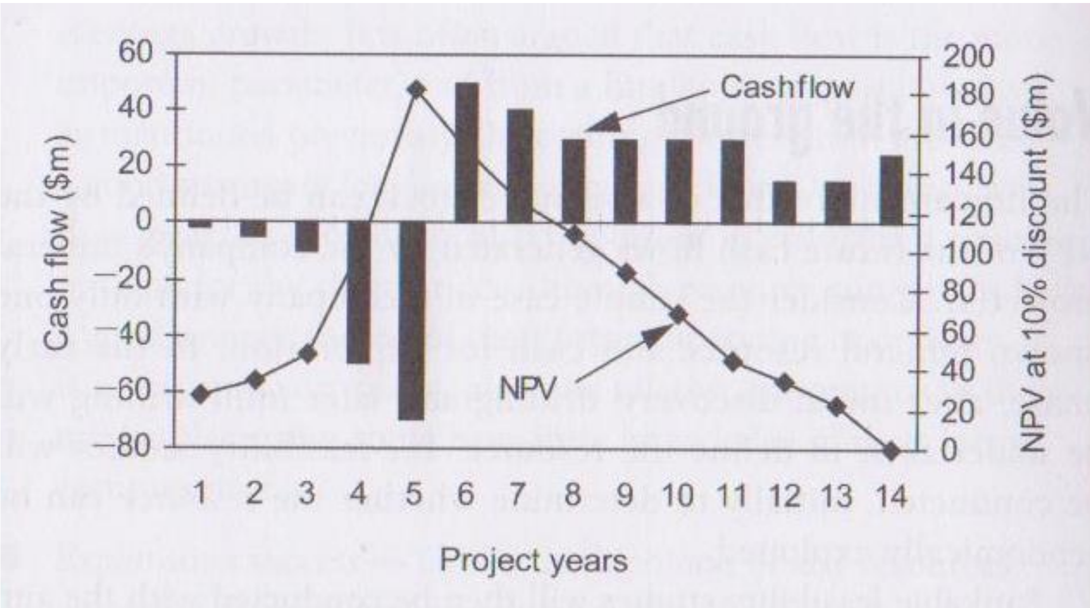
> "For companies with tenements at an early stage of exploration, performance was found to be influenced mainly by exploration strategy adopted and exploration management…The performance of companies with more advanced projects was strongly influenced by both financing strategies and technical management."

In fact, stage-of-development is so intrinsically connected to market valuation that it largely ordains which valuation methodologies can be applied. Quoting Lawrence (2001, p.5), "The choice of the valuation method in a particular circumstance will depend mainly upon the quantity and quality of the available information for the relevant Mineral Assets. This, in turn is dependent upon their development status."

NPV analysis is of special import, but it can only be conducted when a project is sufficiently advanced towards production. In particular, as a NRC develops its project to production, the magnitude and timing of future cash flows is progressively clarified. For instance, as the production stage is approached, issues such as the debt financing terms for the project are revealed, such that knowledge concerning future cash flows comes more sharply into focus. In fact, robust NPV analysis, which is only possible for projects at an especially advanced stages-of-development, contributes significantly to the confidence necessary to support and maintain substantial market valuations. Hence, stage-of-development provides important information concerning the magnitude and timing of future cash flows, as summated by the NPV, and is therefore held to be an important PVF.

Indeed, as a NRC's progressively advances its project to production, market value generally appreciates. However, when mining actually commences, somewhat surprisingly, market value often declines, and often continues to decline thereafter - especially for NRCs with only a single mine. This phenomenon is due to the non-renewability of natural resources: as ore is extracted and sold, reserves and mine-life is progressively depleted. Consequently, expectations concerning the magnitude of future revenues steadily decline, although expenses like mine reclamation remain. Thus, NPV generally rises as a NRC successfully navigates successive stages-of-development to the point of production – at which time NPV often, having achieved its zenith, thereafter declines. Figure 46, by way of a hypothetical example, illustrates this classic rise and fall in a project's NPV – the maximum point marked by the commencement of mining.

Figure 46 - Expected returns given stage-of-development



Source: Rudenno (2010)

In fact, if a NRC holds only one project with any significant prospects of attaining production, the market value of the company will typically follow an identical arc – peaking as mining commences on that project. Nonetheless, Rudenno (2010) notes that, in practice, a NRC will often hold additional projects of adequate promise, or sufficient exploration upside in proximity to the mine site itself, that this pattern does not usually hold. Therefore, rather than myopically focusing on a NRC's flagship, stage-of-development is best viewed holistically, in terms of a NRC's project portfolio. Regardless of how it is viewed, stage-of-development informs the magnitude and timing of future cash flows (that is, NPV), and so deemed an important PVF.

5.3 The Uncertainties and Risks of Future Cash Flows

The previous section emphasised the relationship between stage-of-development and knowledge of the magnitude and timing of future cash flows, and therefore, market value. Relatedly, stage-of-development informs the uncertainty and riskiness associated with these cash flows. Consequently, stage-of-development is deemed a PVF because, beyond information about the magnitude and timing of future cash flows, it also imparts information concerning the uncertainty and risks associated with those cash flows.

According to Trench (2012), there are two distinct sources of risks for a company developing a natural resource project: (1) project risk and (2) corporate risk. Under this model, both project risk and corporate risk vary according to stage-of-development, but in different ways. Project risk can be conceptualised as the likelihood that a project will be successfully developed into a profitable mining operation. As a NRC advances a project, from earliest exploration, through to the most advanced stages-of-development, the project is incrementally 'de-risked.' By contrast, corporate risk relates to the liabilities and associated dangers threatening companies. Typically, corporate risk is low in the early stages of a project's development but rises steeply as feasibility studies and mine development are conducted. Under this model, corporate risk is held to peak during the most advanced stages of mine development and as production actually commences. Indeed, the commencement of production is associated inevitable 'teething problems' - such as unexpected metallurgical complexities that require deft solution – endangering cash flows when debt levels are maximised. In fact, corporate risk is considered to remain high during the early phases of production. For example, the previously described Fortescue Metals Group, several years into successful production, was momentarily threatened in 2012 by unexpected plunges in the global iron ore price – while the company was aggressively ramping up production through debt. Figure 47 traces the typical pattern for project risk and corporate risk as a product of stage-of-development (Trench, 2012). [42]

[42] Figure 47 additionally denotes factors influencing the management of corporate risk, such as the financing mix and ownership structure.

Figure 47 - Project risk and corporate risk given stage-of-development

Source: Trench (2012)

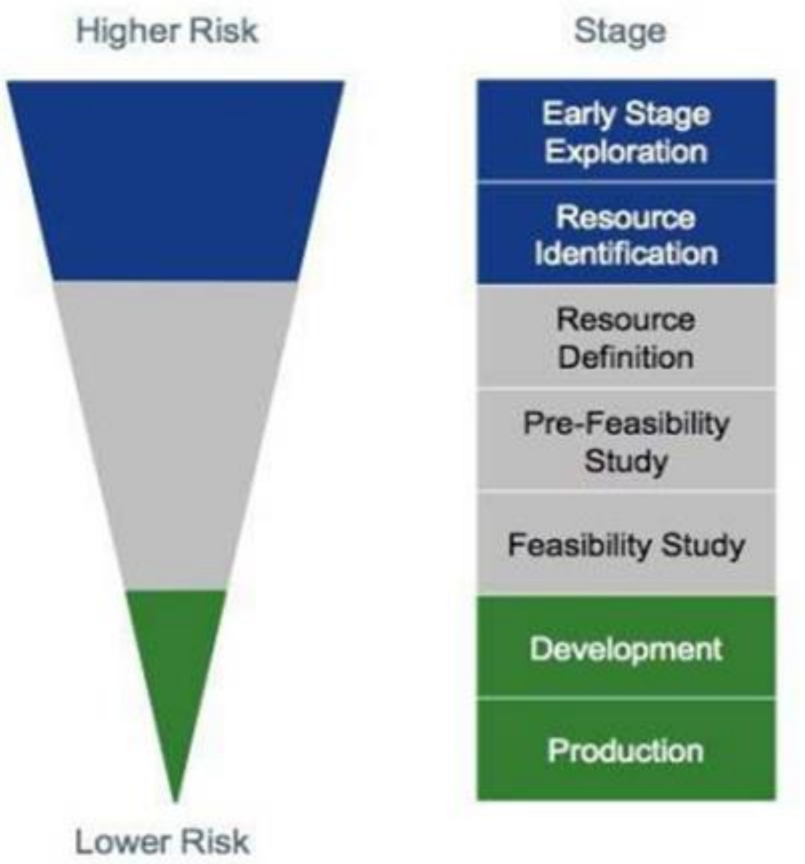
Notably, under this research, the conceptual distinction between uncertainty and risk is enforced. Trench's (2012) conceptualisation of 'corporate risk,' would, under this research, also be deemed risk proper – as, a company's cash outflows and inflows and associated timings are generally calculable. By contrast, this research would consider Trench's (2012) 'project risk' as a measure of 'uncertainty.' Specifically, as a project is successfully piloted through the various stages-of-development, uncertainty is resolved and key developmental milestones are achieved, such that uncertainties are steadily converted into calculable risks. The next two sections provide more detail on Trench's (2012) two conceptualisations of risk, project risk and corporate risk, as they relates to market value.

5.3.1 Project Risk

Project risk measures the intrinsic uncertainty associated with a project and the prospects that it will prove a commercial success. As a project transitions to higher stages-of-development, uncertainty is steadily resolved into risks that can be calculated and thereby managed. As an extreme example, it is difficult if not impossible to estimate future cash flows around an untested drill prospect, uncertainty is extreme, whereas it is possible to calculate the future cash flows, and estimate the probabilities of associated risks to these cash flows, for a project on the verge of production. Indeed, the heightened uncertainty, that is, project risk, associated with earlier stages-of-development versus advanced stages-of-development was reflected in the findings of Kennedy (1996). Her model of performance drivers explained approximately 60% of the variation in performance for NRCs at an advanced stage-of-development, but only approximately 26% for NRCs at an early stage-of-development. Thus, while uncertainty can never be completely eradicated, uncertainty is extreme in the case of NRCs at early stages-of-development, while it is greatly diminished for NRCs at advanced stages-of-development.

The relationship between stage-of-development and risk is illustrated by US Global Research (as cited by Baurens, 2010) in Figure 48. Under this model, risk is referring to Trench's (2012) 'project risk,' while corporate risk is not considered. Again, the term 'risk' as employed here, under this study's framework, actually refers to uncertainty.

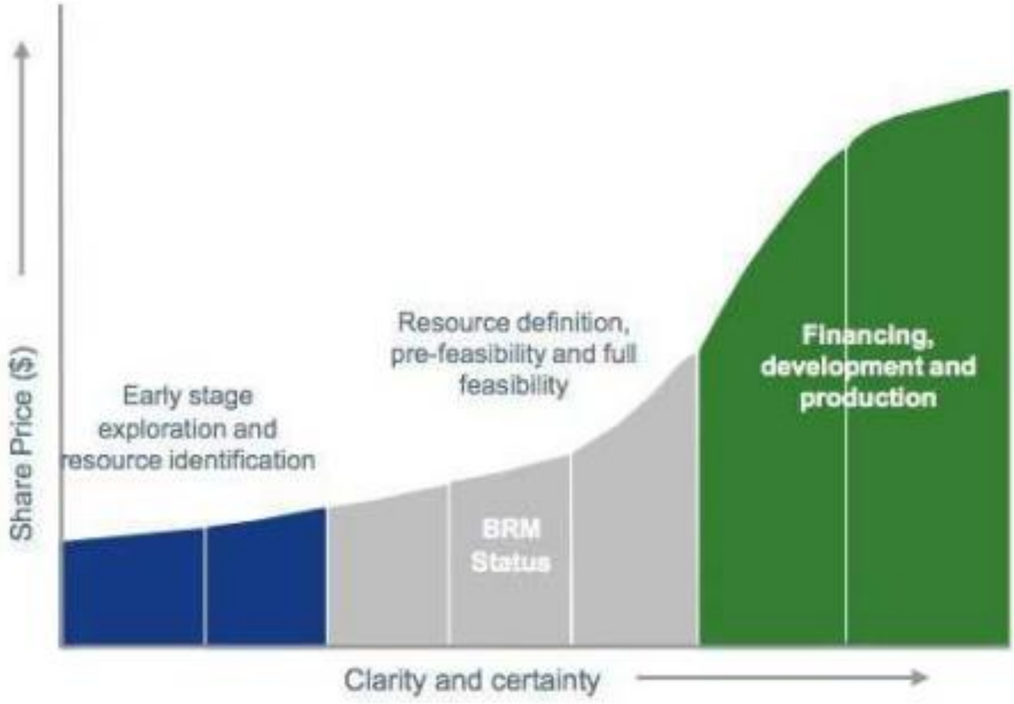
Figure 48 - Relationship between stage-of-development and risk



Source: US Global Research as cited by Baurens (2010)

According to Figure 48, exploration is ascribed the highest 'risk', while resource definition and feasibility studies are considered medium 'risk', and development and production is deemed the lowest 'risk'. Or, in terms of this research's framework, as stage-of-development advances, uncertainty declines as it is transformed into risk: that is, by degrees, into a knowable, and therefore estimable, distribution of outcomes. In addition, US Global Research (as cited by Baurens, 2010) provides Figure 49, for the case of a particular natural resource enterprise (BRM), applying the same 'risk' designations to the various stages-of-development, as a function of share price (that is, market value). Figure 49 underscores the contention that stage-of-development is a PVF informing market value.

Figure 49 - Market value and stage-of-development



Source: US Global Research as cited by Baurens (2010)

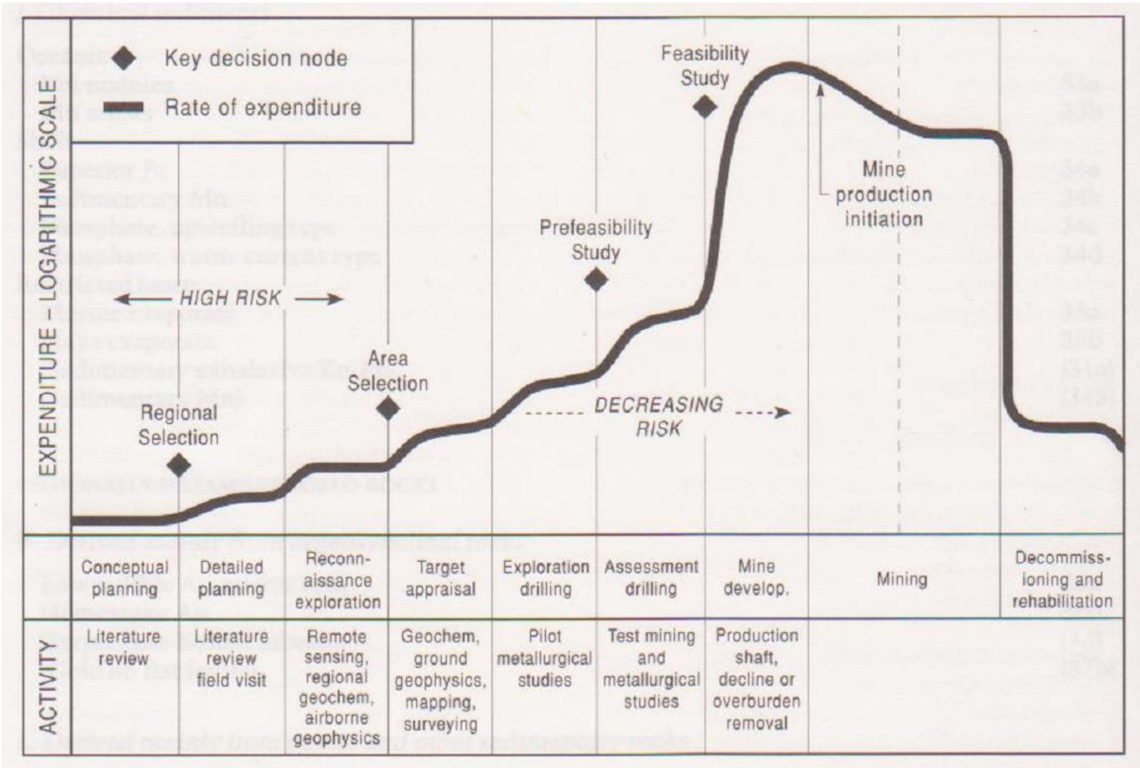
5.3.2 Corporate Risk

As emphasised, corporate risk is a form of risk proper, and generally increases as stage-of-development advances, peaking just before, or with, the commencement of mining. A key factor giving rise to this dynamic concerns the exponential step-up in monies that must be committed to progress a project from an exploration prospect into a productive mine. Generally, in $US dollar terms, grass-roots surveys cost in the order of hundreds-of-thousands, drill testing in the order of millions, and, in order to meet mine-development CAP-X, hundreds of millions or even billions must be committed. Significantly, such expenditures are generally sunk costs and so can't be recuperated. For instance, a barren drill hole is a sunk cost.[43] Similarly, a processing plant is usually engineered to the specifics of a particular ore-body and thus, while it could be sold for use at another ore-body, would necessarily sell for a fraction of its construction cost. Figure

[43] Although it does help narrow the search by definitively demonstrating where there is not any ore.

50 presents the relationship between stage-of-development and expenditure. Notably, Figure 50 also uses the term 'risk' to refer to 'project risk,' whereas, under this research, this would be deemed 'uncertainty'.

Figure 50 - Expenditure and stage-of-development



Modified from Eimon (1988) as cited in Evans, Moon and Whateley (2006)

In fact, comparing Figure 50 to Trench's (2012) depiction of corporate risk in Figure 47, it can be seen that the rate of expenditure effectively proxies for corporate risk. This is because, risk can be calculated as the product of two factors: (1) the amount of money at stake, and (2) the probability that this money will be lost. That is, risk is not only a function of the likelihood of losing money but, equally, the amount of money under risk – as this amount represents the extent of the potential loss. Therefore, risk generally increases as the amount of money irreversibly committed increases. In particular, as a NRC advances its projects closer to production status, the amount of money which must be committed rises exponentially. Consequently, corporate risk increases in lock-step with stage-of-development until such point as the sunk costs have been borne, that is, until just before or as mining commences. By this mechanism, stage-of-development informs corporate risk and, given that the value of any asset is a function of future cash flows alongside the uncertainties and risks associated with these cash flows, stage-of-development is deemed a PVF.

5.3.3 Section Summary

This section has examined the value-relevance of stage-of-development due to the information stage-of-development imparts regarding the uncertainty and risks associated with future cash flows. Especially noteworthy is this work's adoption of Trench's (2012) notion that there are two distinct sources of risk associated with stage-of-development, namely: (1) project risk and (2) corporate risk. Project risk measures the intrinsic uncertainty associated with a project which, as stage-of-development advances, is steadily resolved into manageable risks. In contrast, corporate risk is a measure of risk proper, and generally increases as stage-of-development advances, commensurate with the commitment of capital, peaking just before, or with, the commencement of mining.

5.4 Chapter Summary

It has been shown that the respective stages-of-development of a NRC's projects are value-relevant. This is because stage-of-development informs both: (1) the magnitude and timing of cash flows, and (2) the uncertainties and risks associated with these cash flows. Specifically, valuations are largely a product of NPV analysis and the faith investors' place in this analysis; where faith increases as a project approaches production. Yet, market valuation often declines when mining actually commences. This non-intuitive phenomenon is due the non-renewability of resources; still, market behaviour will depend on the status of a NRC's other projects and its exploration potential.

Given that stage-of-development informs risk and uncertainty, it also relates to speculation - an infamous aspect of the NRS. Accordingly, having discussed the bearing that stage-of-development has on market value in the NRS, the following Chapter considers the role of speculation.

Chapter 6: Speculation Factors

6.1 Chapter Introduction

Stage-of-development, as discussed, is generally reflected in market value. However, as a NRC seeks to progress to the next stage-of-development, it may, under certain circumstances, become the object of market speculation. The term 'speculation', as employed here, refers to an excessively optimistic market viewpoint that produces egregious market inefficiencies: substantial separation between market value and intrinsic value. According to the literature, speculation is a characteristic feature of the NRS; frequently influencing market valuations within the sector. Given the purpose of this research - to investigate how the market values NRCs – speculation is considered an important PVF, and the subject of this chapter.

6.2 Factors Supporting Speculation in the NRS

There are a number of lines of argument within the literature that converge to suggest that the NRS is a hotbed of speculation. These arguments are reviewed presently.

As previously detailed, there is a scarcity of authoritative valuation methods by which to appraise NRCs. Because NRCs are generally free from authoritative standards of valuation, efficient price discovery is potentially impeded and, pointedly, speculation is encouraged. Compounding the lack of authoritative valuation methodologies is a dearth of systematic analyst coverage to apply valuation methodologies. Traditionally, the practise of equity analysis is seen as a balm to market inefficiencies. The special training and experience of equity analysts in the domain of fundamental analysis, and the dissemination of that knowledge, is held to facilitate efficient price discovery. Such an assertion has been supported by Schutte and Unlu (2009) who found that the 'noise' component of equity prices moderated following the initiation of analyst coverage and, further, that this reduction was proportionate to the intensity of the coverage. Such findings complement the previously cited research of Bowen et al. (2008), who found that the quantity and quality of investment analysis reduced the level of SEO under-pricing, presumably by mitigating information asymmetry. Thus, analyst coverage is generally held to moderate pricing inefficiencies. Consequently, the general absence of analyst coverage in the NRS, at least on a systematic basis, might be expected to increase pricing inefficiencies – including speculation.

Schutte and Unlu (2009) found that the curative impact of equity analysis, in countervailing noisy prices, wavered during the tech boom of the late 1990s. Schutte and Unlu (2009) conjectured that this finding could be explained by overconfidence from the speculative excesses of the dot-com era, conjunction with the increased importance of intangible assets and the characteristic erratic cash flows of the dot-com period. Intangible assets and erratic cash flows are also characteristic of NRCs, and coupled with potential overconfidence arising from the commodity price super cycle, might likewise foster noisy and inefficient market pricing within the NRS.

Other characteristic features of the NRS that might impair market efficiency, and consequently support speculation, are low market capitalisations and poor liquidity. In particular, these latter two characteristics, generally preclude the sector from the purview of large sophisticated investors, like pension and hedge funds. Hence, the NRS's investment community likely comprises a relatively large proportion of small investors—who do not have access to the same resources and financial acumen as larger institutional investors. If indeed the NRS's investment community is not as sophisticated as that of other market sectors, the NRS is likely not as efficiently priced. In this vein, Zhang (2006) finds that the market is slower at pricing-in news, that is, is less efficient, for firms with high information uncertainty – where high information uncertainty is proxied by firms of: 1) low market capitalisation, 2) junior age, 3) low analyst coverage, 4) large variation in analyst forecasts, 5) high return volatility 6) and elevated cash flow volatility. All these information-uncertainty proxies characterise the NRS and thus, the NRS is likely a relatively inefficient market sector. Moreover, if the investment prowess of the NRS's investor base is relatively limited, the sector is likely more susceptible to speculative bubbles.

If, as suggested, the investor base for the NRS is relatively unsophisticated, then, by implication, the bandwidth for processing information in the sector may be relatively limited. Despite the potentially truncated informational processing capacity of the NRS, the sector, nonetheless, produces a relatively large deluge of information. The magnitude of this information deluge is a product of the large number of NRCs each of which is continuously issuing news regarding progress across their project portfolios alongside news concerning other business activities - such as the continual need for financing. Thus, as the number of NRCs on global exchanges increased dramatically during the commodity price super-cycle so did their news-flow. It is possible that this informational upsurge from the NRS may be straining the capacity for the market to efficiently capture, process and embed information into the market price. Indeed, for certain stock exchanges, like the ASX, and in the context of the commodity price super cycle, the NRS became the largest issuer of news announcements. Thus, the efficiency of the NRS is likely impaired by the incongruity of a limited information processing bandwidth that is forced to interpret a relative superabundance of information.

The hazards posed by superfluous information on the price discovery process are well documented (e.g. see: Libby, Bloomfield and Nelson, 2002). Indeed, a common misperception is that additional information improves decision making, whereas, oft-times, the accuracy of decision-makers exhibits no improvement (Castellan, 1977; Oskamp, 1982) and may even decline (Arkes, 1981; Zacharakis & Meyer, 2000). Given that information overload is a feature of the NRS investment universe it is likely that investors in the sector may be especially prone to errors. Moreover, the content of the announcements issued by NRCs oftentimes requires highly specialised knowledge. For example, a command of geology is needed to properly interpret news from NRCs updating their various exploration programs. Thus, not only is there a glut of information pertaining to the NRS being released onto global equity markets, but the nature of this information is specialised, and requires specialised knowledge to determine its value-relevance. Further, the value-relevance of this information flow is in many respects unique to the NRS and is interpreted through a prism exclusive to the NRS.

The interpretation of announcements may also be impeded by the way in which NRCs construct announcements. Ideally, from the point of view of investors, announcements would present an objective, dispassionate presentation of a NRC's business prospects, risks and current position. While NRCs have a responsibility to provide such objective information, they also have other, sometimes conflicting, responsibilities. In particular, company directors are charged with creating and protecting shareholder wealth and, to do this, they must attract investment capital. Forster (2005, p.33) notes:

> "A great deal of time and resources of junior mining companies are spent trying to attract investors and the attention of the financial community to the company. Investor relations activities are often some of the largest expenditures made by a junior mining firm, requiring a budget of as much as 25% of the operating capital to sustain. When activity in the industry decreases due to a downturn in the cycle, access to capital deteriorates."

Furthermore, to attract investment capital there is a powerful motivation to amplify positive information while ‘downplaying’ negative information. To do otherwise could forestall needed potential investment and perhaps even contribute to the company’s insolvency, thereby eroding the shareholder value the directors were charged with protecting and building. Thus, announcements are generally not impartial: rather they are crafted products often replete with hyperbole and selective information. This is not unique to the NRS – such a charge is common to all venture-capital, and, perhaps to a lesser degree, larger established enterprises. Naylor (2007, p.90) emphasises the dangers of such biases in the NRS – where the urge to influence investor opinion, taken to an extreme, corrupts all semblance of truth and manifests itself by fraud:

> “And who can really pinpoint where professionally-convenient myopia grades into “willful blindness?” True: one step further down that slippery slope are instances which involve, not merely the overlooking of something inconvenient, but the deliberate dissemination of false information. Yet in a field where, at least in the short run, the search for development money so often depends more on (theological) faith than (geological) fact, and where the end product (real or imagined) dazzles judgment as easily as eyesight, the distinction between over-confidence and a straight-forward con job can be rather murky.”

The informational processing capacity of the NRS is also likely impaired if insider trading is a sufficient scourge to the NRS that non-insider market participants are discouraged to the point withdrawing from the sector. While insider trading can, in the short-term, improve market efficiency – so called strong-form market efficiency - it can impede efficiency longer-term, by discouraging investors from an inequitable market and concentrating value-relevant information amongst a smaller group of insiders (Fishman & Hagerty, 1992). Indeed, there is evidence to suggest that insider trading is a significant bane within the NRS. Bird et al. (2013) found highly suggestive evidence that insider trading is ubiquitous in the Australian natural resources industry – with much of the price action elicited by exploration and resource announcements actually preceding the announcements. In an empirical examination of the ASX, Poskitt (2005) found that insider trading is indeed active within the resource sector, particularly for exploration stocks relative to mining stocks. Nonetheless, Poskitt (2005) finds that insider trading is active in other market sectors, and, rather than being sector-specific, is a function of market capitalisation. In particular, insider trading is negatively related to market capitalisation, such that micro-capitalisation are a special refuge for insider trading. Such a conclusion confirms Loughran and Ritter's (2000, p.3) insight that ‘‘. . . just about every known stock market pattern is stronger for small firms than for big firms.’’ Whatever the cause of insider trading, its presence in the NRS may discourage more market participants, which may have the effect of reducing the sector's market efficiency and its propensity for speculation.

Lawritsen (1993) draws attention to the distinctive investment environment of the NRS, distinguished by a constant but irregular news flow which occasionally catalyses dramatic share price fluctuations, observing that such an environment is ideally constructed to induce gambling-like behaviour on the part of investors. Such an environment, Lawritsen (1993, p.26) notes, is classified by psychologist as "variable-ratio reinforcement" - an intoxicating environment which compels gambling behaviours. Variable-ratio reinforcement is considered among the most seductive means of drawing investors into irrational, gambling behaviour. More generally, variable-ratio reinforcement underlies the explicit design of games of chance, such as lotteries. Lawritsen (1993, p.26):

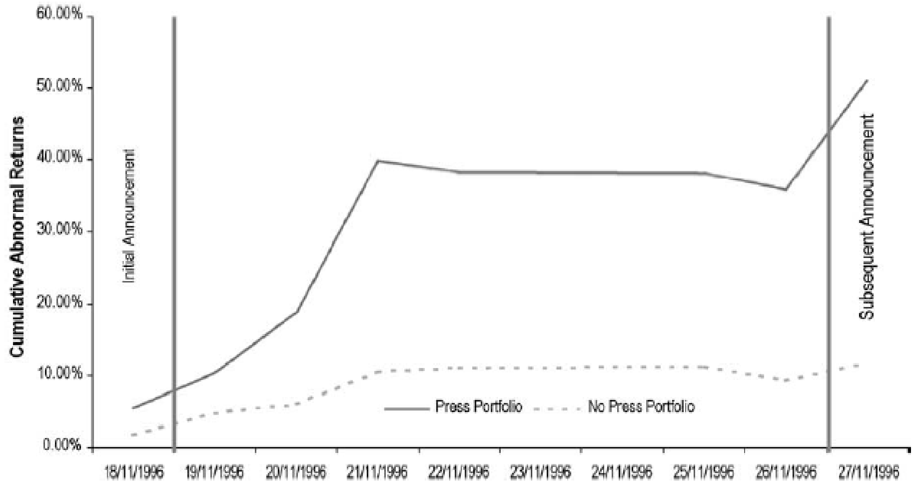
> "The chronic gambler, who is exposed to a variable-ratio reinforcement schedule, literally cannot quit. The occasional and unpredictable reinforcement is to the delight and profit of the casinos – enough to keep the gambler going through very long stretches without any reinforcement. In a similar vein, an investor in a mining company is waiting for that big one to come in. Since the wins and losses are coming in different magnitudes and different times the investor is essentially being conditioned by a variable ratio reinforcement schedule. Over time the investor becomes more conditioned and less objective in assessing the nature of the investment."

In a related vein, Kumar (2009) found that lottery-like stocks, that is, low-priced stocks with both high idiosyncratic volatility and skewness, are preferred by individual investors, but avoided by institutional investors. However, Kumar (2009) found that, as a group, individual investors suffer for that preference, with lower benchmark returns. Hence, the variable-ratio reinforcement of the NRS – marked by lottery-like stocks with expected average losses in conjunction with unpredictable massive individual returns, is a potential contributor to speculation within the sector.

The NRS, bedevilled by the aforementioned factors, is a potential candidate for speculative excesses. Even from a more generic, market-wide perspective, Graham and Dodd (2009, p.164) conclude that "security prices…are not determined by any exact mathematical calculation of the expected risk, but they depend rather on the popularity of the issue." Suggestively, there are studies showing that variations in cash flows, and expectations of variations in future cash flows, capture only half of the variation in market prices (for example Cutler, Poterba and Summers, 1989). There is disagreement within the literature as to whether this extra-volatility reflects fundamental fluctuations in underlying risk through time or, alternatively, is evidence of the inherent market inefficiencies. One potential explanation for excessive volatility beyond that justified by variable cash flows was provided by Merton (1987). Merton (1987) built on asset pricing theory by introducing the assumption of variable investor recognition, concluding that investor recognition would be positively associated with market prices while, equivalently, reducing expected returns. Analysing this potential empirically, Richardson, Sloan and You (2012) confirmed that much of the extra-volatility is attributable to variation in investor recognition, especially over the short term. Richardson et al. (2012) estimated that annual returns are influenced by investor recognition to the same approximate order of magnitude as the underlying fundamentals. Thus, market prices are, potentially, not mere reflections of underlying fundamentals, but, also, their current popularity, that is investor recognition.

An important study demonstrating the value-relevance of investor recognition to the NRS is Ferguson and Crockett (2003) which focussed on the impact of an exciting drilling results in South Australia by Helix Resources in 1996 resulting in the share price of the NRC multiplying more than seven-fold in little more than a week. However, the focus of Ferguson and Crockett (2003) was on the value-relevance of the discovery on other NRCs who held exploration tenure in the general vicinity – given the assumption that the discovery by Helix Resources had increased the prospectivity of the surrounding area. Ferguson and Crockett (2003) found that those NRCs who received the most media attention following the results of Helix Resources generally enjoyed the largest share price gains, although these same firms also subsequently experienced long-run underperformance.

Figure 51 - Press versus no press portfolio



Source: Ferguson and Crockett (2003)

Figure 51 demonstrates the dramatic difference between a portfolio comprising those NRCs which were cited by the press in relation to the discovery by Helix Resources against a portfolio of companies which were not cited.

Consequently, there appears to exist a strong incentive for NRCs to seek increased investor recognition – especially given the often dire need to raise capital, which, as previously discussed, is a task greatly facilitated by heightened market prices. Such an incentive may manifest itself, amongst other behaviours, by news announcements saturated with hyperbole. Evidence for this might explain Bird et al.'s (2013) finding of substantial outperformance for natural resource enterprises employing positive adjectives in the announcement titles of exploration results.[44] Musing on the results overall, Bird et al., (2013, p.323), suggest that:

> "…when results are easily quantifiable, there is no association between word usage and returns. This result provides an interesting insight into the regulation of exploration results, with managers being restricted in their ability to report geological data, but being free to describe the results in whatever way they like."

The importance of 'spin' is also a feature for the *dot-com* era of the late 1990s – a period which, aside from representing a much cited speculative bubble, is, in at least some respects, an analogue for the rise of the NRS under the commodity price super-cycle. Cooper, Dimitrov and Rau (2001) found that during the *dot-com* era firms who changed their name to reflect an internet-related association experienced roughly a 74 percent increase in market value during the ten days following the announced name change. This was surprising from a rational perspective given that the actual level of association with the internet was apparently unrelated to the sharp increase in market value. Notably, firms with low or absent internet related sales were found to enjoy the largest long-run returns.

If speculation is really a perennial force in the NRS there is clearly a market failure, in particular, rational investors are unable to nullify the activities of speculators by shorting NRCs trading in excess of their intrinsic value. In fact, the capacity for rational investors to take the other side of the market during such speculative excesses can be hampered by synchronization risk: uncertainty as to when other rational traders will decide to short ebullient stocks (Abreu & Brunnermeier, 2002; Abreu & Brunnermeier, 2003). In particular, as the market price represents the average assessment of price at any point in time a single investor cannot, generally, move the market by any material

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[44] Bird et al.'s (2013) sample overwhelmingly comprised NRCs.

amount. Consequently, rational investors may seek to coordinate their actions with other rational investors allowing irrational prices to persist. Indeed, rational traders may actually exacerbate irrational prices by profiteering from short-term trends. For instance, Brunnermeier and Nagel (2004) examined the trading of hedge funds during the *dot-com* bubble, and found that these sophisticated market participants actually intensified the boom by investing in dot-com companies during the bubble and scaling down their investments before the ensuing crash. The preoccupation with share price, to the point where rational analysis is, potentially, rendered superfluous is articulated by a Canadian broker, Mr. Kaiser (as cited by Lawritsen, 1993, p.27), "…when you are betting on long-shots, you are speculating on speculation, not on success." Thus, the potential for such market failure might equally apply to the NRS, which would support the continuance and enlargement of speculative bubbles.

In sum, the NRS is acted upon by a number of potential forces that, in concert, are expected to impede efficiency and increase the likelihood of speculation, namely: 1) minimal and sporadic professional analyst coverage, 2) ubiquitous intangible assets and erratic cash flows in the context of a commodity price super cycle, 3) dearth of authoritative valuation methodologies – NPV analysis being inapplicable for most NRCs and the appraisal of exploration acreage introducing a surfeit of uncertainty that generally corrupts robust valuations, 4) a relative scarcity of sophisticated investors, 5) under the influence of the commodity price super cycle a deluge of news, 6) the interpretation of news from the NRS generally requires a high degree of specialised knowledge, 7) relatively high degrees of insider trading, 8) an investment domain which approximates irregular news flow which resembles variable-ratio reinforcement thereby inducing gambling behaviours, 9) powerful incentives for investors to attract heightened investor recognition – potentially through hyperbole, and 10) market failure impairing the capacity for rational investors to nullify speculation. Thus, there is reason to suspect that the NRS might harbour relatively high levels of speculation.

6.3 Speculation through PVFs

Assuming that the NRS does support relatively high levels of speculation, the question becomes what PVFs are value-relevant in part because these factors encourage speculation? In this vein, Graham and Dodd (2009, p.348) reflect:

> "…even when the underlying motive of purchase is mere speculative greed, human nature desires to conceal this unlovely impulse behind a screen of apparent logic and good sense."

Rephrasing then, what apparently logical and sensible PVFs commonly give rise to speculation within the NRS? Such speculation-inducing PVFs are considered presently, in particular, exploration drilling and commodity-type.

6.3.1 Speculation through Exploration Drilling

A PVF that commonly serves as a catalyst for speculation within the NRS is drilling of relatively unexplored prospects. At this early of stage-of-development, uncertainty is acute, and the results of such maiden drilling programs promise, and routinely deliver – if the results are sufficiently favourable - instantaneous *multi-baggers*. Quoting Naylor (2007, p.90):

> "…every so often stock markets are driven into a frenzy by rumors that some intrepid explorer has stumbled across King Solomon's Mines, perhaps the most geographically peripatetic mother-lode in history."

The potential for speculation at this early stage-of-development is a product of the overwhelming uncertainty that accompanies exploration drilling – particularly into relatively virgin ground - and hence, the uncertain probability of stupendous returns.

Still, it remains perhaps impossible to definitively prove that such dramatic share price rises, due to high initial expectations concerning the possibilities of a drilling program (and subsequent falls, due to ultimate disappointment) result from speculation. That is, these dramatic share price rises and falls may, despite the appearances of a bubble, actually reflect rational assessments of value. Specifically, the high initial expectations might have been a rational assessment of the probabilities and potential pay-off of the drilling prospect given the information available at that time. This reflects a fundamental truism concerning the efficiency of equity markets. Specifically, any test which finds that a market is inefficient is either correct or the test itself is misspecified (i.e. lacking a robust method by which to determine whichever is the case).

Nevertheless, the literature is suggestive that, in many cases, speculation, not rational expectations, is the common market response to exploration drilling, especially the drilling of relatively unexplored areas. This would include the previously discussed historical case of Tasminex NL – a hitherto little known Company whose share price multiplied more than 30 times in a matter of days over the faulty perception that nickel sulphides had been encountered on drilling.

An important study focussed upon the market's preparation for, and subsequent reaction to, the results of NRC's exploration drilling is Lawritsen's thesis (1993), titled "*Destabilizing speculation in mining companies IPOs: An analysis of trading in shares surrounding assay result announcements*", Lawritsen (1993) built on the work of Long, Shleifer, Summers and Waldmann (1990), who suggested a model where the actions of rational speculators might not, as is commonly assumed, move prices towards intrinsic value but rather, at least in the short-term, move prices away from intrinsic value. Specifically, Long et al. (1990) suggested that rational speculators might buy, not based only on intrinsic value, but also in anticipation of positive-feedback speculators, who buy when the price are increasing and sell when prices are decreasing. Under this model the purchases of rational speculators cause the current price to rise, which attracts purchases by positive-feedback speculators, to whom the rational speculators sell.

Based on this model, Lawritsen (1993) hypothesised that trading around the release of assay results by NRCs would be explainable under the model espoused by De Long et al. (1990). In particular, Lawritsen (1993) suggests that, given impending assay results, rational speculators will seek to destabilise prices through purchasing shares ahead of positive-feedback speculators. Thus, as the destabilised shares of the NRC trend higher on the purchases of rational speculators, positive-feedback trader, whose primary investment signal is price, would purchase shares. Thus, under the model, while the positive-feedback trader were purchasing the rational speculators would be selling.

Lawritsen (1993), to test the above mentioned model, sampled NRCs who listed on the Vancouver Stock Exchange, which has since been merged into the TSX-V, from July 1987 to December 1990. Only companies with projects in British Columbia were selected in order to homogenise the sample. Next, approximately twelve thousand pages of the Vancouver Stock Watch were manually perused to identify assay result announcements. However, illiquid companies were subsequently removed from this sample, with the final sample comprising sixty-three announcements for assay results released over the three year period. For the release of each of these sixty-three assay results, capturing fifty-one distinct companies, an event window was tested commencing thirty days prior to the release of the assays until nine days thereafter. The results of regression analysis generally confirmed this model. Lawritsen (1993) provides Figure 52 – depicting the average closing prices for the sixty-three assays over the even window – with assay results released on day 31. While Figure 52 is suggestive of the hypothesised model, with a considerable run-up in prices prior to the assay release – Figure 52 is unsound on methodological grounds. In particular, as Lawritsen (1993) emphasises, the amalgamation of such simple averages is unsound, with, for instance, "companies whose shares were trading at $8.00 would have 16 times the influence of a share trading at $.50 in the calculation of an average." Nevertheless, the regression analyses by Lawritsen (1993) generally confirmed the general intuition of Figure 52.

Figure 52 - Closing prices surrounding assay results

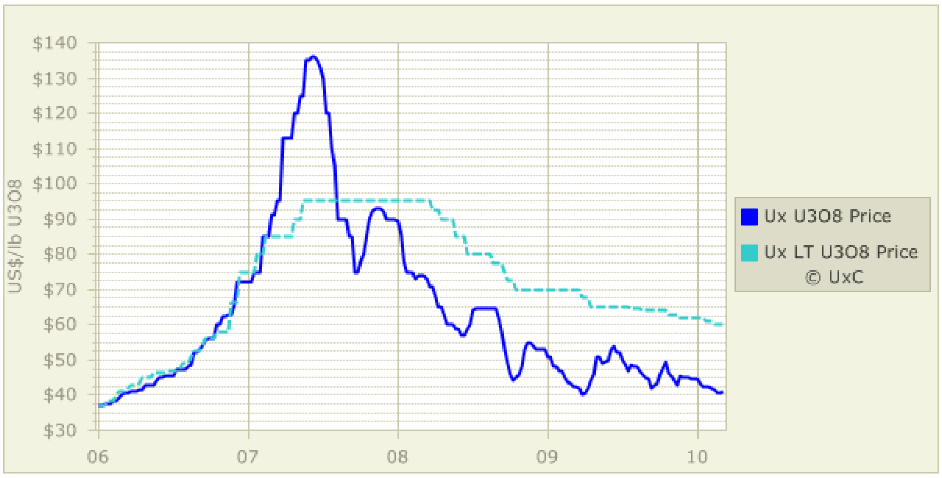
Source: Lawritsen (1993)

6.3.2 Speculation through Commodity-type

Another PVF that commonly elicits speculation within the NRS is commodity-type. In particular, when the price of a particular commodity substantially outperforms other asset classes, investment flows are often directed to NRCs focussed upon that commodity. A historical episode of such a commodity lead boom include the infamous Poseidon/nickel boom of the 1960s and early 1970s. More recent examples include the uranium *bubble* of 2006 and 2007, as depicted in Figure 53 below.[45]

[45] Incidentally, the definition of a boom-bust cycle is somewhat arbitrary and dependent upon the time interval chosen. For instance, in the example above, the uranium price rising from ~US$30 per pound to over US$100 per pound before falling back to ~US$30 per pound might equally be viewed as part of a larger, and continuing, boom in prices, given that uranium prices were floundering at around at less than US$10 at the beginning of the 21st century.

Figure 53 - The uranium boom and bust



Source: Uxc Consulting Company (2010)

Within Figure 53 'Ux 308', represented by the continuous line, is the spot price for uranium while 'Ux LT 308', represented by the dashed-line, is the long-term price for uranium.

The impacts of the boom in uranium prices on uranium-focussed resource companies, and the interrelated speculative dynamics, are articulated by Warwick Grigor (as cited in Avery, 2010, p.22):[46]

> "Speculation multiplies with lack of reliable information. Shares [of listed uranium companies] ran to ridiculous levels on nothing more than hot air and loose money. Analysis wasn't worth the time it took to prepare and was frequently an impediment to making money. More recently it has been the lack of speculation that has had the biggest impact on the market, and it is the reason why it has been the worst performing sector. All the negatives are in the market and there is precious little optimism…No matter how professional the industry players present it, the strong element of gambling should not be ignored. Add to that the ignorance of most investors when it comes to the technical issues, especially in uranium, and the hyperbole which saturates ASX releases."

Speculation usually emerges for NRCs focussed upon a specific commodity-type when that commodity experiences a large price rise. Consequently, the literature suggests that a considerable self-selected number of NRCs often seek to associate with the current *hot commodity*. Given the mobility of NRCs, and the global nature or the business, it is generally possible for NRCs to secure exploration ground that is at least prospective for the current hot commodity. Such behaviour is in accord with the powerful incentive, previously discussed, to augment investor recognition (for instance, see Merton, 1987), through the specific means of associating with the current hot commodity.

[46] Incidentally, Warwick Grigor was formally a business partner of the previously discussed leader of Fortescue Metals Group - Andrew Forrest.

A superficial consideration would conclude that fluctuations in the price of the commodity in which a NRC is focussed should, on rational grounds, be positively correlated with fluctuations in that NRC's market value. Such a conclusion is certainly reasonable in the case of NRCs at an advanced stage-of-development, either currently or soon to be mining the said commodity-type. But why NRCs at an early stage-of-development, who are yet to even discover an economic resource of any kind, should be influenced by short-term fluctuations in the price of the commodity they are merely targeting is not justifiable and strong evidence of speculation. Even if these NRCs were to discover an economic resource in the commodity of interest tomorrow it would still take many years, usually upwards of half a decade, to bring that new resource into production. Indeed, owing to the recurrent role that serendipity holds in the mineral exploration domain it is commonplace for a NRC targeting a particular commodity to discover a resource for a totally different commodity (Swiridiuk, 2010). Thus, in the case of NRCs at the exploration stage-of-development, that is, in the case of most NRCs, short-term commodity price fluctuations should probably not have any material impact on market value, given that it not current or short-term commodity prices that matter, but rather the price which reigns many years into the future. From an efficient market perspective there should be no relationship between changes in a particular commodity price and the market values of the subset of companies within the NRS exploring for that commodity. If such a relationship exists it is strong evidence for the presence of market inefficiency and commodity-focussed speculation in the NRS, as discussed by Cruise and Griffiths (1987).

Thus, the relationship - that, according to the literature is prevalent - between the market value of NRCs exploring for a particular commodity and the price of that commodity is of questionable rationality. For a given NRC such a relationship would only be rational if the rise in the NRC's market value was commensurate with improved expectations regarding its future net cash flows. Such a relationship would only be rational if investors are anticipating that the said commodity price will continue to appreciate, or at least sustain its current buoyant levels, longer-term. Indeed there is some evidence suggesting that long-term commodity price movements are not random walks but in fact follow trends (Andersson, 2007; Stevenson & Bear, 1970). The dominant contention within the literature concerning the nature of these *trends*, based upon both theoretical and empirical grounds, is that they exhibit the property of mean reversion

(Baker, Mayfield, & Parsons, 1998; Schwartz, 1997). That is, commodity prices gravitate towards their long-run marginal cost. Accordingly, once the price of a commodity rises above its long-run historical trend the only rational prediction is that – based upon mean reversion, the dominant finding of the literature - the increase will, eventually, reverse itself. Indeed, the very possibility of profitably exploiting any such trends with reliability is questioned by Rudenno (2004, p.42):

> "Empirical studies of past forecasts have shown that the success rate for commodity price forecasting is very poor. The world commodity markets are very complex and, more often than not, it is some unforeseen event that causes markets to take a direction other than the consensus view."

Thus the relation, purported by the literature, between the market value of NRCs and the outperformance of the commodity they are targeting is probably not rational, but rather evidence of speculation. Hence, there is strong evidence to suggest that NRS is an ideal hotbed for speculation. Moreover, two particular PVFs have been forwarded as potential mechanisms by which speculation can manifest, namely, green-field exploration drilling and commodity-type.

6.3.3 Section Summary

This section suggested how two PVFs (i.e. exploration drilling and commodity-type) can, under certain conditions, engender speculation within the NRS. Thus, while the concept of speculation itself may be somewhat ethereal, its manifestation via quantifiable PVFs allows its inclusion in this research.

6.4 The Inverse of Speculation

Speculation is a fundamentally difficult issue to empirically test because its source, if it indeed exists at all, investor psychology, is difficult to objectively analyse. Speculation, as the term has been applied thus far, refers to excessive investor optimism concerning the prospects of NRCs – beyond that which an objective review of the available facts would warrant. Thus, it is conceivable that excessive investor optimism might, equally, give-way to excessive investor pessimism in some circumstances. Specifically, speculation can be viewed as irrational sentiment, and thus, the influence of speculation is also evidenced by what occurs when such excessively positive sentiment evaporates and even turns hostile - such a phenomenon is herein referred to as *inverse speculation*.

On a fundamental level, financial markets, including the monetary system itself, are based upon trust. This truism extends to the NRS, perhaps even more so, given the general lack of tangible assets to fortify the sector from market vagaries. When this trust is broken in spectacular fashion, it can affect the entire sector. In particular, the literature contends a single NRC can, through infamous actions, negatively impact valuations across the NRS. It might be argued that depreciating the entire NRS – due to the actions of a few rogue NRCs – is an irrational over-reaction. Such a perspective is adopted here, and leads to this phenomenon being conceptualised as the inverse of speculation. Some case-studies that potentially dramatize this phenomenon are now considered.

Brown and Burdekin (2000) conducted an event study based on the infamous case of Bre-X Minerals Ltd, a NRC that reported a major gold discovery in 1995, at Busang, Indonesia. On the strength of the discovery Bre-X quickly became a multi-billion dollar enterprise. However, in 1997 the discovery turned out to be an elaborate fraud – perhaps the biggest in mining history – and the stock was soon worthless. It has been is conjectured that the fraud, so egregious in nature, may have compromised trust and thus market valuations across the NRS. Indeed, Brown and Burdekin (2000) found that the Vancouver Composite Index (the predominate marketplace for NRCs) fell some 25% in the 6 weeks following the Bre-X debacle with smaller companies the most affected. Brown and Burdekin (2000, p.288) concluded their research with:

> "Perceptions, and sector valuations, plummeted almost overnight and financing possibilities dried up in the wake of the Bre-X fraud. The collapse of the junior mining stocks serves as a reminder that a whole sector can be brought down by a single, precipitating event. Investor confidence is especially important in asset markets that rely heavily on uncertain future events. Fraud and misinformation in one instance leads investors to re-evaluate the quality of the information provided by similar firms. In markets where reputation plays a critical role in assessing the quality of information, such events often lead investors to assume the worst for the remaining firms as well."

This case is not unique, in similar research Magness (2009) found that an environmental accident at the Placer Dome mine negatively impacted market valuations across the Canadian natural resources sector. Such depressed markets, affecting only the NRS in isolation, and due to the behaviour, or misbehaviour, of an isolated NRC are presented as examples of inverse of speculation.

Nevertheless, the NRS is resilient, and, human nature being what it is – appears irrevocably drawn to the sector's potential to deliver fabulous fortunes from left-field. Following the Bre-X debacle, trust within the NRS was widely prognosticated to have been so outrageously compromised, that it would be a long-time returning. The following quote from Naylor (2007, p.119 & 120) reveals the fallacy in such predictions:

> "Since gold fever is a disease that goes occasionally into remission but seems never to be cured, a more sensible forecast would have been that, given a little time (very little, actually) for bad memories to fade,…Bre-X or any of the multitude of other kindred enterprises would come to be rationalized as the aberration rather than the rule, or as near misses that failed to deliver the dream only because early investors lacked faith and stamina. […] precious metals have such a special lure based on myth and magic, not to mention the possibility of fantastic returns, that naïve or greedy investors are likely to put their suspicions on hold and dig themselves in ever deeper."

Consequently, speculation, and its inverse, are deemed important PVFs within the NRS, and their role in the sector is not expected, at least for the foreseeable future, to dissolve.

6.5 Chapter Summary

The term 'speculation', as deployed in this work, denotes irrational exuberance in market prices as compared to intrinsic value. This Chapter has shown that the NRS is susceptible to speculation given the convergence of a number of factors. Pointedly, speculation is deemed a PVF because, as it is usually associated with other PVFs, specifically exploration drilling and commodity-type, it is, at least to some degree, systematic and thereby quantifiable. The inverse of speculation, potentially excessive depression of market prices across the NRS was also discussed.

Notably, this Chapter's assertion that commodity-type facilitates speculation underlies the importance of macroeconomic factors to the NRS. Thus, macroeconomic factors are discussed in the following Chapter.

Chapter 7: Macroeconomic Factors

7.1 Chapter Introduction

The previous chapter suggests the NRS is relatively susceptible to speculation. It was observed that commodity prices, a macroeconomic factor, could heighten the potential for speculative bubbles to erupt within the NRS. Nonetheless, macroeconomic factors, such as commodity prices, are also PVFs for the NRS on entirely rational grounds. This chapter investigates such rationally-based macroeconomic-PVFs.

Macroeconomic-PVFs are relevant to the NRS because the industry operates in a global context. The natural resources industry is arguably the most globalised industry in existence: the competitive landscape and the customer base for the NRS is global. Indeed, commodities are, almost by definition, fungible - such that mines compete on a global basis and sell their product to global markets. Gordon and Tilton (2008, p.6) reflect that:

> "The important mineral commodities are typically sold in international markets, so mineral economics took globalization for granted long before the concept became prominent."

Accordingly, macroeconomic-PVFs have an important bearing on the NRS. In particular, commodity prices, the subject of the next section, are not the product of local economies, but are the product of macroeconomic factors.

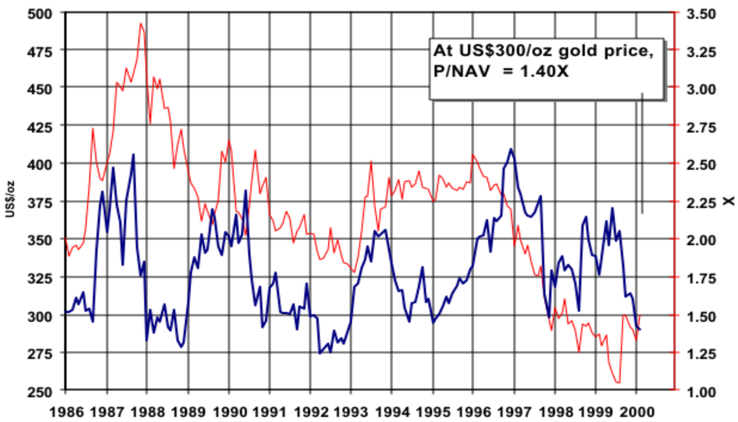
7.2 Commodity Prices

The event focussing this research - the rise to prominence of the NRS commencing in 2005 - is generally attributed to a super-cycle in commodity prices. As discussed in the previous chapter, there is persuasive evidence to suggest that appreciating commodity price can, especially for NRCs at an early stage-of-development, catalyse speculative bubbles. Nonetheless, commodity prices are also a PVF on entirely rational grounds – particularly for NRCs at an advanced stage-of-development. Specially, the revenue of NRCs with operational, or soon to be operational, mines is a product, in large measure, of prevailing commodity prices. In particular, the market valuation of current and near-terms producers will appropriately rise because strengthening commodity prices shall, ceteris paribus, translate to increased profitability. Likewise, declining commodity prices will negatively impact profitability and thus have a deleterious effect on the market values of NRCs operating, or soon to operate, mines. Accordingly, there is often a logical rationale underpinning the association between commodity prices and the market valuation of NRCs – particularly those at an advanced stage-of-development.

In many cases, the association between commodity prices as traded on global markets at any given time (often called the *spot price*) and the revenues of producers, will be moderated if the producers are hedged. Established by contractual agreements, hedging gives producers certainty by locking-in the price at which their mined output is sold for a specified period of time. Nevertheless, the prices that can be secured under such contracts are generally related to the spot price prevailing at the time the agreement was struck. Consequently, long-term trends in commodity prices are eventually reflected in the revenues of both unhedged and hedged producers. Furthermore, many producers in the NRS are not hedged; electing to sell a portion, or the entirety, of their mined output directly to the spot market - especially if management holds a bullish opinion concerning future commodity prices. Thus, there is generally a positive association between the market value of NRCs with, or soon to have, operational mines and commodity prices – although this association can be tempered, at least in the short-run, by hedging contracts.

In fact, NRCs at a sufficiently advanced stage-of-development (i.e. current or near-term miners) often trade above their NPV as they provide an implicit option to capitalise on rising commodity prices, by, for instance, increasing production. Equally, if commodity prices fall, NRCs have the option of slowing, or even halting, operations until commodity prices improve. These options provide inherent value over what simple NPV analysis would suggest. Companies operating gold mines, in particular, are well known for trading at a premium to estimated NPV (Roberts, 2000). This is evidenced, for the case of senior Canadian gold producers by Figure 54. In Figure 54, the red line represents the gold price, as denoted by the vertical left-hand axis, whereas the blue line represents the multiple at which senior gold producers are trading above estimated NPV, as denoted by the vertical right-hand axis.

Figure 54 - Price to NAV for gold producers and the gold price



Source: National Bank Financial cited by Roberts (2000)

NRCs operating, or soon to operate, productive mines can be conceptualised as options over commodity price fluctuations. Such a viewpoint is espoused by Okyere-boakye (2012, p.581) for the case of precious metal shares, “For many years investors have been treating gold and platinum stocks as option proxies to the underlying commodities.” Grullon et al. (2012) argues that firm value increases with volatility in some underlying process, that firms can exploit, increases. This real-options perspective recognises that a NRC operating a mine could increase production when commodity prices are elevated and scale back production when commodity prices are depressed; such that the value embedded in these options is positively related to the volatility of commodity prices. Empirical support for such a contention is provided by Moel and Tufano (2002) who analysed, over the 1988-97 period, decisions to open and close 285 North American gold mines. They found that the predictions of real-options theory was borne out and concluded that the price and volatility of gold (among other factors) was related to mine openings and closures within their sample. Consequently, volatility in commodity prices is more than a revenue-based PVF, volatility can also provide firms with options that are inherently valuable.

Rising volatility in commodity prices often elicits large price reactions for NRCs with operational, or near term operational, mines (e.g. for gold mining firms, Tufano (1998) reported that a one percent movement in the gold price was associated with a two percent movement in the company’s value). The potential for large price reactions is especially acute for NRCs, given their relatively small market valuations. Naylor (2007, p.90) vouches for this effect in gold and silver NRCs:

> “Shares of junior companies are particularly volatile – since they are issued for pennies, small changes in the world price of gold (or silver), real or just anticipated, can cause enormous swings in stock ‘value’”.

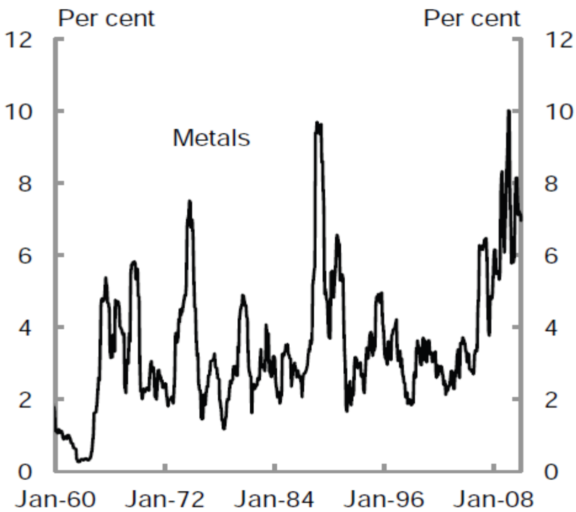
Indeed, owing to the relatively modest market valuations of NRCs, positive news can, and routinely does, result in stocks re-rating too many multiples of their initial value. Moreover, for NRCs operating mining assets, large price reactions often stem from the *leverage effect* engendered by gyrating commodity prices. (van Eeden, 2006a) explains this leverage effect by way of example:

> “Mining stocks also offer leverage to commodity prices. Take a gold mining company as an example. Assume we have a company that mines gold for a total cost of $400 an ounce, and let us pretend the gold price is $500 an ounce. The net present value of the mine would be calculated based on the $100 margin. If the gold price increases by 20% to $600 an ounce the net present value of the mine will double, since the margin would now be

> $200 an ounce. Thus the value of the company increased five times more than the increase in the gold price. Most people buy mining stocks because of this leverage."

Thus, owing to the leverage effect, even modest price upticks in a commodity can have dramatic impacts on a NRC's market value if it is operating (or near to operating) a mine that is only marginally profitable or sub-profitable at previous commodity prices. The sensitivity of NRCs at an advanced stage-of-development to commodity prices (aside from the leverage effect) is often potentiated by the extreme volatility of commodity-prices. Bodie and Rosansky (1980) analysed the variation in commodity future prices for the period 1950-1976 and reported standard deviations of 47.2, 25.6, and 25.2 percent for copper, silver and platinum respectively. As previously noted, Jacks et al. (2011) found that volatility in commodity prices has, over the past three centuries, been significantly greater than that of manufactures. Further, spectacular market successes in the NRS are often at least partially attributable to a substantial appreciation in commodity prices (e.g. in the previously cited transformation of the Fortescue Metals Group from an obscure NRC trading at several cents per share into a multi-billion-dollar enterprise was largely attributable to a dramatic increase in commodity prices). In 2003 the price of iron ore was only US$30 per tonne but, within just five years, it was trading at some US$200 per tonne (Burrell, 2013). Accordingly, the remarkable volatility in the market value of NRCs who are either producers or near-term producers, is often a reflection of volatility in commodity prices. The volatility of commodity prices is itself volatile, with commodity prices experiencing irregular peaks and troughs in volatility (Figure 55). That volatility is represented by the standard deviation of monthly percentage changes with rolling yearly windows.

Figure 55 - Historical volatility in global metal export prices

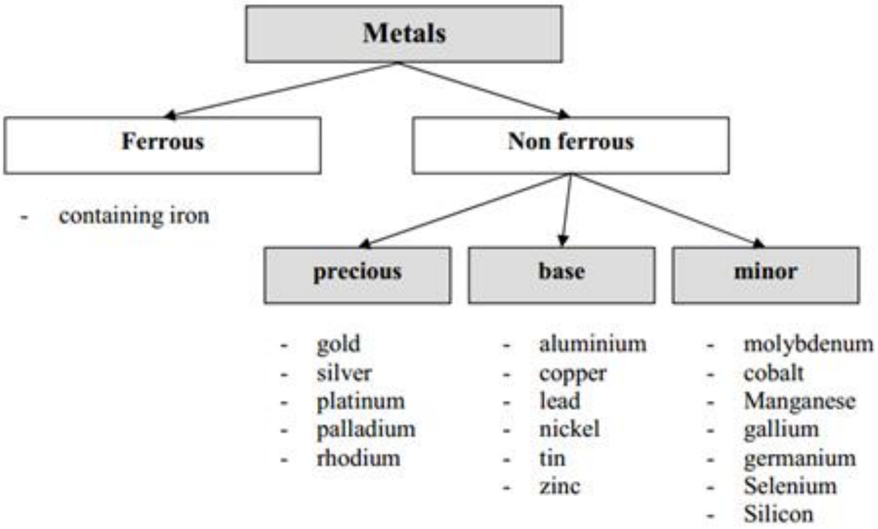


Source: Devlin, Woods and Coates (2011)

Figure 55 reveals the extreme rise in volatility since the turn of the 21st century: a consequence of the commodity-price super cycle. This second order derivative of commodity price volatility has important consequences, for instance, the value attributable to the phenomena discussed thus far – like the leverage effect and the option value of potentially boosting or curtailing production - is itself volatile.

There is persuasive evidence that the value of NRCs (at least those at an advanced stage-of-development) logically varies with commodity prices. More specifically, while the NRS encapsulates a large number of miners producing a myriad of commodity-types the value of a particular NRC is a function of the specific commodity-types that NRC is currently, or soon to be, producing. Thus, for a given NRC, the specific commodity-types of value-relevance must be identified – as opposed to commodity prices in aggregate. This is because commodity prices are not perfectly correlated and can even be negatively correlated. For example, during a recession, commodity prices, in aggregate, decline. Nevertheless, if governments respond to the recession with stimulative measures – particularly, with attempts to increase the money supply - investors may, wary of the potential for future inflation, view gold as a hedge and a necessary addition to their portfolio. Under this scenario investors may, in their collective clamour to acquire gold, bid-up its price. Consequently, gold prices can, under certain macroeconomic conditions, be negatively correlated to commodity prices more generally. Thus, for any given NRC, the commodities of value-relevance are those that the NRC is presently producing, or will be producing in the near term. Thus, in studying PVFs in the NRS, it is important to realise that commodity markets and prices are heterogeneous. To help provide some order to this innate heterogeneity, for the case of metals, Kernot (1999) provides Figure 56.

Figure 56 - Classification of metals



Source: Kernot (1999)

While only representing a subset of metals, and thus not an exhaustive enumeration of every commodity-type, Figure 56 does indicate some of the organising structures underlying commodity markets. Under this taxonomy, ferrous-metals are separated from non-ferrous metals, and non-ferrous metals are further divided between precious, base and minor metals. Partly underpinning the tripartite classification of non-ferrous metals is the insight that while the price of base metals and minor metals is a function of global supply and demand, the market for minor metals is much smaller with minor metals commonly produced as a by-product of other mined products. Consequently, minor metals are prone to higher levels of price volatility because the production of minor metals is relatively insensitive to prevailing commodity prices. Meanwhile, precious metals prices are not, as might be assumed, primarily a function of global supply and demand – but rather depend upon investment flows. Thus, even under this relatively gross taxonomy, the essential heterogeneity of commodity markets comes into sharp relief. In particular, each commodity-type is to a greater or lesser degree idiosyncratic and can, from a pricing perspective, move with relative independence.

Nevertheless, while any given commodity-type differs from aggregate commodity prices, commodity prices are highly correlated (Pindyck & Rotemberg, 1990). This is due to underlying common factors that affect all commodity-types in a unidirectional manner. One factor, alluded to earlier, stems from the notion that commodities are *real* assets, and hence afford some protection against inflation. Thus, if investors are concerned about inflation levels they might purchase, in addition to gold, commodities more generally.

Consequently, an expectation of heightened future inflation might increase commodity prices which may, in turn, be reflected in strengthening market prices for those NRCs at an advanced stage-of-development. A related macroeconomic factor that commonly influences aggregate commodity prices is the US dollar. In particular, most commodities are denominated in US dollars, and, consequently, commodities are generally negatively correlated to movements in the US dollar. Although the influence of the US dollar is, in a sense, only nominal, it holds the potential to produce real effects if it influences investor behaviour. Thus, macroeconomic factors, including inflation and the US dollar, are value-relevant to the commodity markets and, by implication, to NRCs.[47] To summate, the function served by the NRS is to discover, develop and ultimately mine natural resources to extract valuable commodities. Consequently, commodity prices, as well as the volatility of commodity prices, are a PVF for companies at an advanced stage-of-development or those already in production.

7.3 Global Economic Growth

The previous section established that commodity prices are an important PVF to the NRS. Further, the previous section noted that those macroeconomic factors that affect commodity prices, such as the US dollar and inflation, are also PVFs. Global economic growth, insofar as it impacts commodity prices, is likewise a PVF within the NRS. The impact of global economic growth upon commodity prices is the subject of this section.

Global economic growth rates are deemed an important macroeconomic-PVF. Economic growth rates are generally held to exhibit a long-term cyclical pattern: where periods of above trend growth are followed by periods of below trend growth (Helbling, Huidrom, Kose, & Otrok, 2011). Pointedly, expansions and contractions within the natural resources industry usually reflect this global, as opposed to national or regional economies, economic cycle. This is because commodities are the necessary physical input to economic growth, such that the aggregate demand for commodities is a function of global economic growth rates. In turn, the aggregate demand for commodities influence commodity prices which, thereby, inform investment flows to the natural resources sector. Thus, the natural resources industry, as the supplier of raw materials to the global economy, is generally beholden to global macroeconomic cycles.

[47] Some economists would argue that inflation and the US dollar are - at least from the perspective of the US – synonymous.

Nevertheless, the typical measure of economic growth rates, gross domestic product (GDP), is an imperfect measure by which to judge the demand for commodities and thus cyclicality in the NRS. GDP is a financial variable, the outcome of multiplying the number of goods and services produced by an economy by the price at which those goods and services were purchased. By contrast, the relevant metric by which to estimate aggregate demand for commodities is, not GDP, but rather the number of goods produced by the economy. Thus, while GDP serves as a convenient proxy for the global demand for commodities, it can be misleading.

In particular, the recent commodity price-super cycle, the period to which this research is directed, is not simply a product of above trend global growth rates, but is a product of the quantity of commodities required to create this growth. This point is emphasised in the following quote from Devlin et al. (2011, p.5):

> "Led by strong growth in emerging economies, global economic growth averaged 5 per cent per annum between 2004 and 2007 — the strongest four year growth period since the early 1970s. To a significant extent, the strength of the growth impulse from emerging economies was unexpected. Moreover, this global economic growth cycle was commodity-intensive."

Thus, the nature of the economic growth is determinative, with the industrialisation process of emerging nations, like China, which precipitated the commodity price super-cycle, especially commodity-intensive. For instance, many historical commodity price-booms are attributable to increased demand for metals and inventory build-ups during war-time, as witnessed, for instance, by the Korean War (Radetzki, 2006). Consequently, global economic growth rates, coupled with how dependent this economic growth is on commodity inputs, are important PVFs for the NRS.

7.4 Global Investment Flows

Thus, for NRCs at advanced stages-of-development, commodity prices, and indirectly, other macroeconomic factors that influence commodity prices, are considered PVFs. Aside from commodity prices, another leading PVF for NRCs at advanced stages-of-development, is exchange rates. Exchange rates are determined by global investment flows and trade patterns. In turn, exchange rates have a direct bearing on the earnings of NRCs operating mining assets. More specifically, given a particular NRC, the exchange rate of the nations in which that NRC is operating mining assets, as well as the nations in which that NRC is listed, with respect to the US dollar, are considered important PVFs. Notably, NRCs with operational mines generally earn US dollar based revenues, given that most commodity-types are denominated in US dollars. Consequently, if the nation where the NRC is operating a mine does not employ the US dollar as a medium of exchange, the NRCs must convert the US dollars earned into the local currency in order to pay operating expenses such as wages. Similarly, if the NRC intends to pay dividends to investors in nations where the company is publicly listed, and if these nations do not employ US dollars, then the NRC must convert US dollars into the nation's domestic currency. Thus, the cash flows of NRCs with operational mines are influenced by exchanges rates, and so exchange rates are deemed an important macroeconomic-PVF.

Aside from exchange rates, the value-relevance of commodity prices has been repeatedly emphasised throughout this chapter. However, thus far, this discussion has mainly focussed upon the influence that demand factors have on commodity prices. Equally important, to the determination of commodity prices, are supply-side factors. In particular, the cyclicality of investment in the natural resources industry asserts a determinative influence on the creation of new mines and, thereby, the supply of commodities. Indeed the NRS is renowned for investment cyclicality (Low, 2011). For example, in the Australian natural resources industry, Blainey (1993, as cited by Kennedy, 1996), reports that such boom and bust investment patterns occurred at least once every decade from the 1860s onwards. As previously discussed, this cyclicality in investment patterns is largely a product of cyclical commodity prices.

Notably, given the multi-year lead times involved in the development of new mines, current investment flows do not impact the supply of commodities until many years into the future. Some authorities argue that this multi-year disconnect between investment and the creation of new mines actually works to exacerbate, rather than counteract, commodity price volatility. Specifically, high commodity prices encourage increased investment in new mines, but do not immediately counteract the high commodity prices. Years later, the increased investment translates into new mines that can result in supply gluts and thus sustained depressions in commodity prices. Depressed commodity prices generally result in prolonged investment droughts for the sector. Such extended under-investment supports high commodity prices in the future as current mines reach the end of their mine-life and are unable to step-up production to the extent required to meet demand shock. Thus, the cycle is self-reinforcing: cyclical commodity prices beget cyclical investment that, given the long-lead time disconnect, beget cyclical commodity prices (Forster, 2005). As a case in point, Devlin et al. (2011) cites chronic under-investment in the natural resources industry, resulting from an extended period of depressed commodity prices, as a leading supply-factor giving rise the recent commodity price super cycle.

Exploration investment is considered especially sensitive to economic conditions and associated investment risk tolerance, given its intrinsic high-risk, high-reward character. Accordingly, during downturns, companies first look to curtail non-essentials, like exploration expenditure. For example, consider the GFC, and the economic aftershocks flowing from this event: according to Pohl (2011) global exploration expenditures for metals and industrial minerals was some US$14.4 billion in 2008, but by 2009 this figure had fallen to just US$8.4 billion.[48] Forster (2005) cites work by the Metals Economic Group concerning the previous major cyclical lull in exploration expenditures, where, from 1997 to 2002, global exploration expenditures contracted from more than US$5 billion to less than US$1.5 billion. Given that the root source of future mines is, investment in the exploration process, such cyclicality in exploration expenditures does affect the supply pattern of commodities over the longer-term.

Accordingly, given that the NRS is predominately focussed upon the business of exploration, the cyclicality of exploration investment is a vital PVF for the sector. Indeed, contractions and expansions in exploration investment generally reflect contractions and expansions in the NRS. The cyclicality of investment flows then, represents a PVF within the NRS. Such cyclicality in the NRS is related to the buoyancy or otherwise of global financial markets. In particular, buoyant global markets are associated with reduced risk premiums, which benefits riskier investment propositions like the NRS.

Still, global markets can be buoyant and risk premiums low and the natural resources sector can, nonetheless, remain stubbornly anchored to the low point of its cycle if risk capital is elsewhere engaged. One such example would be the dot-com of the late 1990s and early 2000s, where risk-capital flocked to support venture-capital dominated internet related enterprises. Despite the excessive risk-capital that marked the period, the NRS languished; as noted above, in the five years following 1997, global exploration expenditures plummeted from more than US$5 billion to below US$1.5 billion. Regarding this period, Ericsson (2010, p.6) reminisces:

[48] Excluding ferrous metals and coal.

> “Political and public interest in the mining industry waned and it was referred to as the ‘sun set’ or ‘smoke stack’ industry. An industry without a future, as metals and mineral in abundance would flow into Europe from the mines of the Third World. These developments show that mining is a cyclical industry, whether the profitability of the sector or the political interest it creates is considered.”

Thus, it is somewhat ironic that this period marked the prelude for perhaps the greatest mining boom in history, ushered in by the tailwinds of the commodity price super-cycle. Nonetheless, the import of buoyant market conditions for the NRS is supported by previously discussed literature into the IPO market. For example, How (2000), as well as Dimovski and Brooks (2008), investigating the IPO market for ASX-listed NRCs, concluded that market conditions predicted the extent of IPO under-pricing. Thus, the buoyancy or otherwise of global markets, is considered to be readily reflected in the pricing of NRCs, through the medium of risk tolerance.

One potential mechanism by which risk tolerance influences the valuation of NRCs is the credit cycle, the willingness of financial institutions to provide credit and, equally, for consumers to tap this credit. In particular, collateral for margin loans is not restricted to larger, established ‘blue-chip’ enterprises, but also includes NRCs. By way of example, the first page of stocks approved for margin lending from one of Australia’s leading Banks – the Australia and New Zealand Banking Group (ANZ) - effective as of September 2009, is presented in Table 18. A perusal of the listings reveals a considerable portion of NRCs – which are highlighted in yellow for clarity.

Table 18 - Margin lending approved stock

ASX Code	Stock Name	Std %	Div %	Res	ASX Code	Stock Name	Std %	Div %	Res
AAC	Australian Agricult. Fpo	50	80		ALF	Australian Leaders Fpo	-	70	Y
AAD	Ardent Leisure Group Stapled	50	70		ALK	Alkane Resources Ltd Fpo	-	40	Y
AAM	A1 Minerals Limited Fpo	-	40	Y	ALL	Aristocrat Leisure Fpo	70	75	
AAR	Anglo Australian Fpo	-	40	Y	ALR	Aberdeen Leaders Fpo	-	55	Y
AAU	Adcorp Australia Fpo	-	40	Y	ALS	Alesco Corporation Fpo	60	80	
AAX	Ausenco Limited Fpo	40	70		ALU	Altium Limited Fpo	-	40	Y
AAZPB	Australand Assets Assets	60	70		ALZ	Australand Property Stapled	60	75	
ABC	Adelaide Brighton Fpo	60	70		AMC	Amcor Limited Fpo	70	80	
ABCXX	Adelaide Brighton Placement	60	70		AMH	AMCIL Limited Fpo	50	60	
ABJDA	Australian Biodiesel Def Set	-	35	Y	AMM	Amcom Telecomm. Fpo	-	45	Y
ABP	Abacus Property Grp. Stapled	60	75		AMP	AMP Limited Fpo	70	70	
ABQ	Allied Brands Ltd Fpo	-	40	Y	AMU	Amadeus Energy Fpo	-	70	Y
ABY	Aditya Birla Fpo	-	65	Y	AMUXX	Amadeus Energy Placement	-	70	Y
ACB	A-Cap Resources Fpo	-	40	Y	AND	Andean Resources Ltd Fpo	-	40	Y
ACE	Advanced Engine Fpo	-	40	Y	ANG	Austin Engineering Fpo	-	50	Y
ACK	Austock Group Ltd Fpo	-	50	Y	ANN	Ansell Limited Fpo	70	80	
ACL	Alchemia Limited Fpo	-	40	Y	ANP	Antisense Therapeut. Fpo	-	30	Y
ACR	Acrux Limited Fpo	-	40	Y	ANZ	ANZ Banking Grp Ltd Fpo	75	80	
ADA	Adacel Technologies Fpo	-	40	Y	ANZPB	ANZ Banking Grp Ltd Pref	75	80	
ADG	Adtrans Group Fpo	-	45	Y	AOD	Aurora Sandringham Unit	-	65	Y
ADN	Adelaide Resources Fpo	-	40	Y	AOE	Arrow Energy Fpo	40	70	
ADU	Adamus Resources Fpo	-	40	Y	APA	APA Group Stapled	60	75	
ADY	Admiralty Resources. Fpo	-	40	Y	APD	Apn Property Group Fpo	-	55	Y
AEC	Ammtec Limited Fpo	-	45	Y	APE	A.P. Eagers Limited Fpo	-	40	Y
AED	AED Oil Limited Fpo	-	40	Y	APH	Ascent Pharmahealth Fpo	-	40	Y
AEF	Australian Ethical Fpo	-	35	Y	API	Australian Pharm. Fpo	40	60	
AEO	Austereo Group Ltd. Fpo	60	80		APN	APN News & Media Fpo	70	80	
AEU	Australian Education Unit	-	50	Y	APSSM1	Macquarie Alps Mqbde10Cw	-	65	Y
AEZ	APN European Retail Stapled	-	60	Y	APSSM2	Macquarie Alps Mqbse11Cw	-	65	Y
AFI	Australian Foundat. Fpo	70	75		APSSM3	Macquarie Alps Mqbjn12Cw	-	65	Y
AFPHA	Alpha Financial Prod Ser1Fm12	-	75	Y	APSSM4	Macquarie Alps Mqbjn13Cw	-	65	Y
AGF	Amp Capital China Ord/Units	50	75		APSSM5	Macquarie Alps Mqboc13Cw	-	65	Y
AGG	AngloGold Ashanti Cdi 5:1	50	70		APZ	Aspen Group Stapled	50	70	
AGI	Ainsworth Game Tech. Fpo	-	40	Y	AQA	Aquila Resources Fpo	-	65	Y
AGIG	Ainsworth Game Tech. 8% Cn11	-	40	Y	AQNHA	Amp Group Finance. Frn Apr19	65	70	
AGK	AGL Energy Limited Fpo	70	75		AQP	Aquarius Platinum. Fpo 15Cus	40	70	
AGO	Atlas Iron Limited Fpo	-	40	Y	ARE	Argonaut Resources Fpo	-	40	Y
AGS	Alliance Resources Fpo	-	40	Y	ARG	Argo Investments Fpo	70	75	
AHD	Amalgamated Holdings Fpo	50	70		ARH	Australasian Resour. Fpo	-	40	Y
AHE	Automotive Holdings Fpo	-	65	Y	ARP	ARB Corporation Fpo	40	70	
AIA	Auckland Internation Fpo NZ	50	80		ARU	Arafura Resource Ltd Fpo	-	40	Y
AII	Abra Mining Limited Fpo	-	30	Y	ASB	Austal Limited Fpo	40	80	
AIO	Asciano Group Stapled	-	75	Y	ASL	Ausdrill Limited Fpo	40	70	
AIQ	Alternative Invest Units	-	40	Y	ASX	ASX Limited Fpo	70	70	
AIX	Australian Infrastr. Unt/Ord	60	80		ASZ	ASG Group Limited Fpo	-	45	Y
AIZ	Air New Zealand Fpo NZ	40	65		ATP	Atlas Southsea Pearl Fpo	-	40	Y
AJA	Astro Jap Prop Trust Unit	-	60	Y	ATR	Astron Limited Fpo	-	40	Y
AJL	AJ Lucas Group Fpo	-	50	Y	AUB	Austbrokers Holdings Fpo	40	80	
ALD	Allied Gold Limited Fpo	-	40	Y	AUF	Asian Masters Fund Fpo	-	35	Y

Adapted from Australia and New Zealand Banking Group Limited (2009)

Thus, investors in the NRS are – at least under favourable macroeconomic conditions – able to borrow against their existing NRCs to buy other equities, including, presumably, more NRCs. Such dynamics can become self-reinforcing, declining risk premiums are associated with rising security values, which support more margin-lending driven investment in the NRS, which, in turn, supports higher securities values across the NRS. Naturally, this process can quickly reverse itself, as falling prices engender margin calls which – in an already illiquid sector like the NRS – can engender further prices falls and further margin calls. The GFC is generally held to have precipitated such a dynamic across equity markets, as margin loan positions quickly unravelled, and visibly, the NRS was no exception. Thus, global investment flows, in particular risk premiums, and in association, the buoyancy or otherwise of equity markets, influence market valuations within the NRS.

7.5 Chapter Summary

The accepted literature appears to be in broad agreement that the macro-economy holds a number of important PVFs for the NRS. In particular, for NRCs at an advanced stage-of-development, commodity prices and commodity price volatility are deemed important PVFs. Exchange rates are also noted as a leading PVF for those NRCs at advanced stages-of-development. By implication, factors that influence commodity prices and exchange rates are also value-relevant. Consequently, such factors as inflation, the US dollar, the rate and commodity-intensity of economic growth are deemed important, albeit indirect, PVFs. Finally, the cyclicality in investor risk tolerances, and the associated buoyancy of global equity markets, are also noted as prominent PVFs.

While commodity movements are a leading PVF for the NRS, in order to develop a given natural resource, a myriad of other technical and financial factors must also be considered. The evaluation of these factors, of which commodity prices are but one, is formalised in the feasibility study – the subject of the next Chapter.

Chapter 8: Feasibility Study Factors

8.1 Chapter Introduction

The primary macroeconomic-PVF for the NRS, as emphasised in the previous chapter, is commodity prices. As noted there, commodity prices impact producers' revenue. Additionally, commodity price influence whether in situ resources will be developed. Thus, what constitutes a resource is in large part determined by prevailing commodity prices. Hitherto touted resources, following a decline in commodity prices, may no longer represent economic propositions and, conversely, distained deposits may, following a significant increase in commodity prices, transmute into celebrated, lucrative resources. Still, commodity prices are only one of a number of factors determining what constitutes a viable resource. Ultimately, in order to attract the finance needed to development a resource, a study into the project's economics must be conducted, based upon commodity prices, alongside all relevant technical and financial factors. This study is generally known as a feasibility study, and is the topic of this chapter.

This chapter is divided into two sections. The first section considers with the role and value-relevance of feasibility studies to the NRS generally. Having established these general facts, the second section considers specific PVFs in the NRS associated with feasibility studies.

8.2 The Role and Value-relevance of Feasibility Studies

Rudenno (2010, p.500) defines a feasibility study as:

> "…a technical and financial study of a project at a sufficient level of accuracy and detail to allow a decision as to whether the project should proceed."

Accordingly, feasibility studies are employed periodically throughout a project's development in order to justify additional investment in the project. Thus, projects will not proceed to the next stage-of-development unless the results of a feasibility study are supportive. Still, projects at an early stage-of-development, focussed upon exploration, do not usually admit sufficient quantitative data to allow a feasibility study to be conducted. Generally, feasibility studies are employed once, as a minimum, a resource has been tentatively defined; that is, once future cash flows for the project can be approximated (Baurens, 2010). Once such a resource has been defined, at least to inferred status, the first type of feasibility study, the scoping study, can be conducted. If scoping study results are positive, a successive train of feasibility studies can ensue, from pre-feasibility studies through to bankable feasibility studies (BFS). In general terms, feasibility studies are important in formalising the available information on a project into an assessment of that project's economic potential. Consequently, the primary purpose served by feasibility studies is to validate the investment capital required to transition a project to its next stage-of-development.

Usually, the investment capital required to advance a project rises exponentially with stage-of-development. Therefore, the importance of feasibility studies escalates as stage-of-development progresses. Fortunately, as stage-of-development advances, so does the accuracy of feasibility studies. However, commensurate with improved accuracy, is the time required to complete feasibility studies. These points are denoted in Table 19.

Table 19 - Cost, time and accuracy given feasibility study type

Studies	Cost	Time	Accuracy
Scoping study	$100 000s	Months	Low
Pre-feasibility	$ millions	Months	Fair
Final or bankable feasibility engineering design	$10 millions	Year(s)	Good
Construction phase detailed engineering	$ millions to $100 millions	Year(s)	Very good

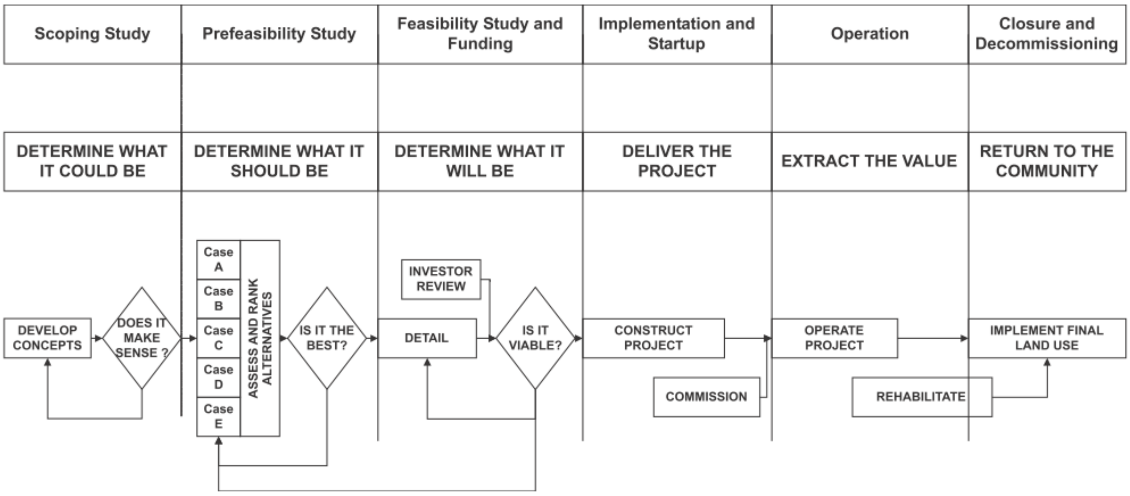
Source: Rudenno (2010)

Thus, feasibility studies vary greatly in terms of financial cost, preparation time and accuracy. Moreover, this variation is mostly a function of the underlying project's stage-of-development.

While feasibility studies are by no means an inexpensive exercise, especially given the limited resources of NRCs, their expense is dwarfed by the capital costs required to bring a project into production. Based on a sample of mining developments, Mackenzie and Cusworth (2007) estimate that the average feasibility costs 2.7 percent of the total project cost. Despite this relatively small cost, Mackenzie and Cusworth (2007) emphasise the importance of the feasibility study as, under the feasibility study, the outcome of the project is most under the control of the company to shape, by, for instance, assessing the optimal developmental pathway for the project. By contrast, once the feasibility study is concluded and construction underway, there is relatively little scope to influence project outcomes.

In Figure 57, the framework under which a resource is brought into production is illustrated and the centrality of the feasibility study in transitioning a project from inception to mine is clearly displayed.

Figure 57 - The project development framework



Source: Mackenzie and Cusworth (2007)

According to Mackenzie and Cusworth's (2007) framework, the initial scoping study serves to clarify a project's economic potential, the prefeasibility study involves determining the optimal developmental option for the project, while the subsequent feasibility study provides sufficient detail concerning the selected development option that investors can decide whether to commit the funds required for construction. Additionally, the model emphasises that feasibility studies are often iterative in nature: if the economics of a project under the final feasibility study are not sufficient to win investor support the company may revisit the prefeasibility stage and look to further optimise the project's cash flow. For example, the prefeasibility study might be repeated to better optimise the inherent trade-off between the rate of production and mine-life, given that higher rates of production equate to shorter mine-life, such that the project's NPV is enhanced. Thus, Mackenzie and Cusworth's (2007) framework shows that the nature of a feasibility study is predicated by the type of feasibility study being conducted. Especially critical, is the final feasibility study, referred to by other authors as the BFS, whose ambit necessarily extends beyond the project's financial aspects. In particular, the BFS considers all relevant stake-holders, such as native title holders, and, amongst other items, an Environmental Impact Assessment (EIA; see, Pohl, 2011). Indeed, the wealth of information that must be disclosed under a feasibility study is considerable, encompassing information from a large pool of disciplines. Considering just the financial aspects of a project, Gordon and Tilton (2008, p.5) note:

> "Mineral economics borrows freely from many, more traditional disciplines, including economics, finance, management, statistics, econometrics, geology, mining and petroleum engineering, mineral processing, fuel science and technology, and metallurgy."

There are, therefore, a myriad of PVFs embedded within feasibility studies.

An excellent case study of a feasibility study, detailing many of the issues involved, is the thesis of Thomas Albanese (1981) – which investigated the economics of an Alaskan deep gold placer. Albanese (1981, p.96) notes that, "A feasibility study of a mining venture is never more than an estimation of the viability of the project. This is entirely dependent on the cost, production, revenue and financing assumptions." This underscores the essential point that a feasibility study is, by necessity, assumption and estimate-laden. Thus, feasibility studies are no guarantee of operational success and, oftentimes, ill-fated assumptions and overly optimistic estimates results in cost over-runs and project failures. Indeed, Thomas Albanese went on to become the CEO of one of the world's largest diversified miners – Rio Tinto – but was dismissed in 2013 following write-downs owing, in part, to a coal project in Mozambique not meeting its feasibility study forecasts (Ker, 2013).[49]

Despite, and perhaps due, to such dangers, feasibility studies are design to be somewhat conservative in nature. In particular, cost-estimates include a margin-for-error, generally between 5 and 15 percent, depending on a project's perceived risks, to absorb potential cost over-runs (Rudenno, 2010). Despite this in-built conservativeness, it is common for NRCs to trade at only fractions of their NPV – as established by feasibility studies. This is particularly the case for projects at earlier stages-of-development and for whom some major developmental milestones, such as debt financing, remain unresolved.

The work of Bertisen and Davis (2008) helps explain the often glaring disconnect between market value and NPV as determined by feasibility studies. Bertisen and Davis (2008), empirically analysing 63 mining and smelting projects, found (consistent with earlier research in the area) that actual capital costs were, on average, overestimated by 14 percent compared to their BFS's estimations. Moreover, approximately 1 out of every 13 projects experienced cost blowouts exceeding 100 percent of that predicted under the

[49] Although the largest contributor to the write-downs resulted from the acquisition of Alcan – an aluminium producer – at an inopportune point in the mining cycle.

BFS. In fact, Bertisen and Davis (2008) contend that the persistent bias to under-estimate capital costs they observe was deliberate, and motivated by the desire to secure scarce project funding. In this vein, Bertisen and Davis (2008) cite earlier research by Vancas (2003), which noted that feasibility studies in the mining industry are often deemed accurate from -5 to +15 percent; an asymmetrical range developed to account for the systematic positive bias observed in the industry. Bertisen and Davis (2008) also found that inaccurate estimates were particularly evident for smaller projects. Given this latter finding it might be expected that the feasibility studies of NRCs, who generally deal in smaller projects, would be especially error-prone.

Accordingly, the favourable bias of feasibility studies, if it indeed exists, acts to impair the value-relevance of feasibility studies. Despite this potential bias, feasibility studies remain, at least in a relative sense, objective summations of a project's economic potential. Further, investors and lenders are expected to scrutinise feasibility studies. Moreover, feasibility studies, irrespective of type, hold a determinative role in transitioning a project to the next stage. As a result, feasibility studies are considered to hold value-relevance to the NRS.

8.3 Feasibility Study based PVFs

The previous section discussed the role of feasibility studies and established the likely value-relevance of feasibility studies to the NRS. Furthermore, the previous section alluded to the potentially numerous PVFs within feasibility studies influencing the market's valuation of NRCs. Fortunately for tractability, under the feasibility study, a wealth of information is distilled into a handful of metrics by which to judge the economic credentials of a given project. These metrics, and other PVFs associated with feasibility studies, is the subject of this section.

Probably the principal metric to arise from a feasibility study is a project's NPV. In fact, according to Rudenno (2010, pp.225 and 285):

> "The most valuable tool that analysts, companies and investors have in determining the fundamental value of a project or company is to discount future cash flows and determine the NPV....The fundamental value of a resource stock can be defined by the NPV of the future cash flows generated by the company's mineral project(s)".

Thus, NPV, as the representation of future cash flows discounted for the time value of money, is the consummate PVF.

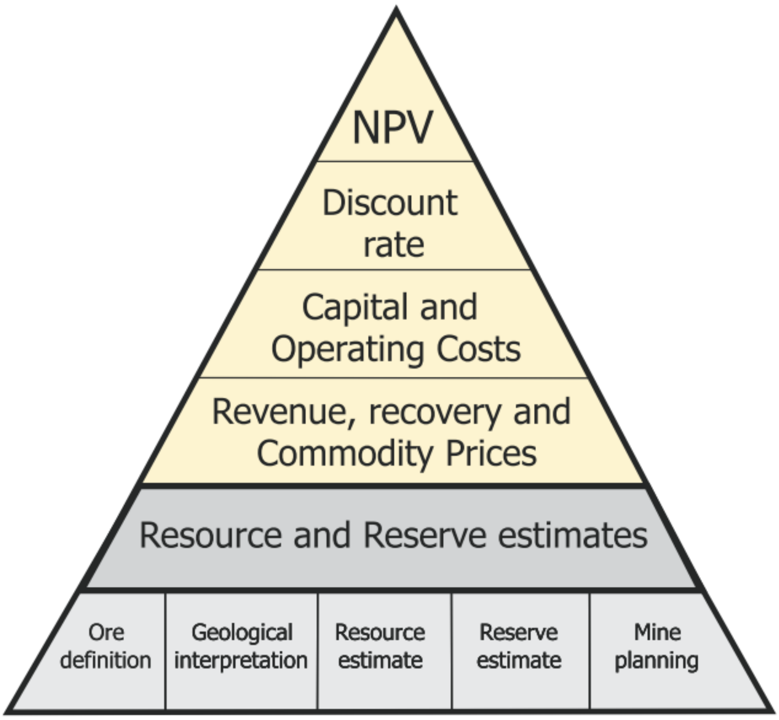
In general, NPV analysis is complemented by sensitivity analysis and stochastic modelling to explicitly demonstrate how a project's NPV changes as major inputs and assumption to the model, like commodity prices and exchanges rates, vary. Such modelling reflects the fact that NPV, and other metrics to arise from the feasibility study, are dynamic and so better expressed in terms of confidence intervals. The importance of modelling such variability under a feasibility study, and thereby deciding whether to continue developing a project, has been recognised in the mining industry for many decades. Markedly, such modelling highlights not just the potential for a project to underperform expectation, but also to outperform. On this note, Albanese (1981) notes that while a feasibility study, under conservative assumptions, must meet a minimum profitability bench-mark, attention must also be paid to potential up-side in the project. Indeed, Rozman (1998) points out that, for the mining industry, risk is not something to be automatically avoided, but rather something to be managed. Rozman (1998) cites the decision to mine, Sunrise Dam in Western Australia and notes that, had the project's *blue-sky* potential not been realised, the project would probably not have developed - with Sunrise Dam going on to significantly surpass its original production estimates. Thus, *plain vanilla* NPV analysis is generally extended, through such techniques as Monte Carlo, to reflect the innately stochastic nature of a feasibility study's inputs and thereby the potential variability in outcomes.

In a sense NPV is the capstone metric of the feasibility study, as it subsumes and distils a bevy of other economic and technical factors. Nevertheless, these factors, if part of the determination of NPV are, by implication, PVFs in their own right. Particularly influential to NPV analysis is the selection of an appropriate discount rate. The discount rate helps proxy for both technical and financial risk, the relative debt-equity mix, anticipated inflation and for the fact that the capital contributed towards the project will be effectively locked-in Runge (1998). In fact Baurens (2010, p.37) remarks:

> "The first variable that has a greatest impact on a discounted cash flow valuation is the discount rate. Depending on the life of the project the different discount rates cause a variation of a more than 50% in the value placed on a project! Consequently it is crucial to calculate an appropriate discount rate."

Consequently, another leading metric and PVF to arise from feasibility studies is the discount rate. Aside from the discount rate, there are host of other technical and financial factors incorporated in the determination of NPV. Figure 58 illustrates which classes of PVFs, such as resource and reserve information, NPV is ultimately derived from:

Figure 58 - NPV as a product of fundamental project information



Source: Snowden, Glacken and Noppe (2002)

Roberts (2000) expresses the same essential point by way of Table 20, and provides more specific identification of the underlying PVFs, which are denoted as "project parameters":

Table 20 – Project parameters and information determining NPV

Project parameter *(Equivalent only in aggregate over the life of mine, and on an average annual basis)	Information taken into account
Geological resource	Geological delineation
Mineable reserve	Mining recovery, economics, other
Recoverable metal	Metallurgical recovery
Payable metal	Pay factor, unit deductions
Gross revenue	Metal prices
Net smelter return	Treatment, refining, transport, penalties
Operating cash flow (=EBITDA)*	Operating costs
Cash flow after capital (=EBIT)*	Capital (initial and sustaining)
Net cash flow (=Earnings)*	Interest and taxes
Net present value	Discounting

Adapted from Roberts (2000)

Notably, both Glacken and Noppe's (2002) Figure 58 and Roberts (2000) Table 20 express the fact the NPV is the cumulative product of all the PVFs denoted. For instance, in Roberts (2000) Table 20, each project parameter listed incorporates all the project parameters above it, cumulatively, such that the final project parameter, NPV, encapsulates all value-relevant project information that can be quantified (Roberts, 2000).

Accordingly, there are a myriad of technical and financial issues that need to be resolved under a feasibility study – all of which may be PVFs. In particular, many of these PVFs cannot be quantified and so are difficult to explicitly capture by NPV analysis, except through the somewhat subjective *umbrella proxy* of discount rate. For the case of a more advanced project these relate to, but are not limited to, environmental plans and policies, mine plans and schedules, occupational health and safety, mining equipment as well as power and water supplies. A relevant study here is Ferguson et al. (2011) that examined 85 natural resource companies on the ASX attempting to take a gold project into production. Key findings from the study were that project failure was more likely for underground developments versus open pit developments and, moreover, whether the feasibility study divulged expected cash costs of production. In particular, companies that disclosed the expected cash costs of production were more likely to succeed. Thus, beyond the disclosures of feasibility studies, the amount of disclosure itself is deemed an important PVF. The stock exchange on which the company is listed may also represent a PVF insofar as feasibility studies are concerned. Aside from representing different investor bases, stock exchanges are governed by differential legal frameworks, and these varying legal frameworks often influence and even mandate the construction of feasibility studies. For example, the disclosure requirements for feasibility studies are relatively prescriptive in Canada whereas Australia affords much greater levels of discretion (Ferguson et al., 2011).

8.4 Chapter Summary

As discussed, a feasibility study is required in order to decide whether the expected economics of a resource merit the additional funding required to progress to the next stage-of-development. While it was noted that feasibility studies generally exhibit a positive bias, they are nonetheless considered to be of value-relevance. Specifically, major outcome metrics of feasibility studies, especially the catchalls of NPV and discount rate, are deemed value-relevant. However, other PVFs associated with feasibility studies (while less obvious) have also been suggested. Specifically, whether the operation is open-cut or underground, whether the expected cash costs of production are disclosed in addition to the stock-exchange in question, have all been hailed as PVFs by the literature.

Feasibility studies, and their financial projections, are ultimately based upon natural resources. Thus, resources and the metrics relating to resources are of value-relevance. Consequently, PVFs relating to resources are considered in the subsequent Chapter.

Chapter 9: Resource Factors

9.1 Chapter Introduction

The underpinning for a feasibility study, insofar as the NRS is concerned, is a natural resource. Indeed, given that NRCs are seeking to discover, develop and mine resources, it is implicit that resources underpin the business model of the NRS. The purpose of this chapter is to outline PVFs associated with resources.

9.2 Confidence in Resources

Conceptually, resources resemble the inventory of industrial companies: resources being the basis for future earnings. However, a principal difference between inventory and resources is the vastly more intense uncertainty concerning whether resources, especially those held by NRCs, will be successfully translated to earnings. The source of this uncertainly stems, in large measure, from a lack of knowledge concerning the resource itself, as Snowden et al. (2002, p.1) states:

> "In mining, the dominant source of risk is the orebody itself. Mining is different from any businesses, because knowledge of the product is based largely on estimates"

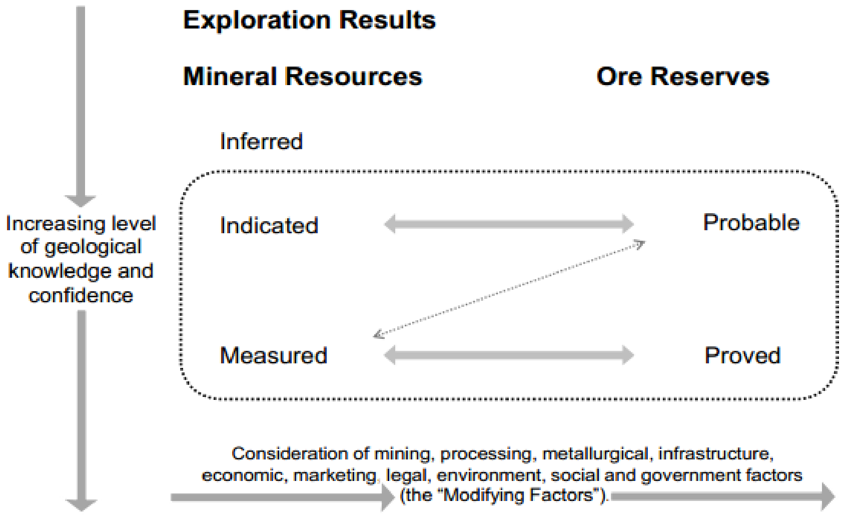
Knowledge of a resource's parameters is typically determined by drilling core samples but, as drilling is costly, only a tiny fraction of the resource is ever drill-tested, with statistical inference supplying the estimate. Consequently, some uncertainty always exists concerning the parameters espoused for a given resource; e.g. one of the key parameters to be estimated in a resource is its grade (i.e. the relative concentration of valuable commodities, relative to waste-rock. Costa Lima and Suslick (2006, p.88) note:

> "In practice, the grade is estimated using appropriate sampling procedures. Nevertheless, because sampling is expensive, in most cases, only around 0.01% of the rock volume is sampled whereas the grade in the space occupied by the other 99.99% must be estimated."

Thus, the confidence that can be placed in a stated resource is, itself, a PVF for the NRS. In fact, the confidence that can be attached to a given resource is a focal point for much of the legal framework governing the NRS. Indeed, a primary function of the JORC Code is to define various levels of confidence that can be attached to a resource (JORC, 2012). Meanwhile, in Canada, the conferral of a given degree of confidence to a resource is governed by the NI 43-101, which was developed by the Canadian Securities Administrators, and is broadly analogous to the JORC Code (Rudenno, 2004). Under the JORC Code (2012) the levels of confidence, in ascending order, for a resource are as follows: inferred resource, indicated resource and measured resource. Once a resource is sufficiently advanced to the point it has been demonstrated to be economically mineable it is categorised as a reserve. A probable reserve is analogous to an indicated resource while a proven reserve is analogous to a measured resource. Thus, the confidence which can be attached to a resource's stated parameters is considered a PVF within the NRS.

Figure 59 illustrates the general relationship and associated confidence-levels associated with the various resource and reserve categorisations.

Figure 59 - Exploration results, mineral resources and ore reserves



Source: JORC (2012)

Apart from denoting the various levels of confidence, Figure 59 also denotes the fundamental "modifying factors" that must be taken into account in order to transition a resource to reserve status. "Consideration of mining, processing, metallurgical, infra-structure, economic, marketing, legal, environment, social and government factors," are all deemed important factors in establishing that a given resource is indeed feasible to mine, and may thus be categorised as a reserve (JORC, 2012, p.9). The pre-eminence of reserves is emphasised by Baurens (2010, p.41) who declares, "The fundamental asset which underpins the value of any mining project is its ore reserve". Moreover, Taylor, Richardson, Tower and Hancock (2012, p.396) reflect:

> "The disclosure of both proved and probable reserve disclosures is a requirement under the JORC and provides useful information about the confidence that the firm has in those reserves and is thus a potential reflection of the confidence in future cash flows of the firm."

Empirically, the value-relevance that reserves impart to market values over resources is demonstrated by Ludeman (2000) in an analysis of major gold transactions in the 1990s. In particular, Ludeman (2000) found that proven and probable reserves are afforded a 44 percent discount while measured and indicated resources are afforded an 83 percent discount. Thus, whether a resource is designated as a resource or a reserve is considered a PVF.

9.3 Resource Size and Grade

Aside from the legal designations that may be attached to a given resource, the actual parameters of a resource are clearly PVFs. Two primary resource parameters deemed by the literature (e.g. Rudenno, 2010; Lonergan, 2006) as leading PVFs are: 1) grade, and 2) size (i.e. physical dimensions over which the resource occurs). The import of a resource's grade and size are affirmed by Pohl (2011, p.414):

> "Hardly any obstacle will prevent exploitation of large and rich deposits, whereas low-grade or small occurrences cannot be mined, even if all other parameters are optimal".

Larger resources are preferred because they support larger mines and rates of production, and, thereby, economies of scale minimise the cost per unit produced. Meanwhile, smaller resources generally compensate to some degree by superior grade (Pohl, 2011). Rudenno (2010, p.38) emphasises the value-relevance of grade:

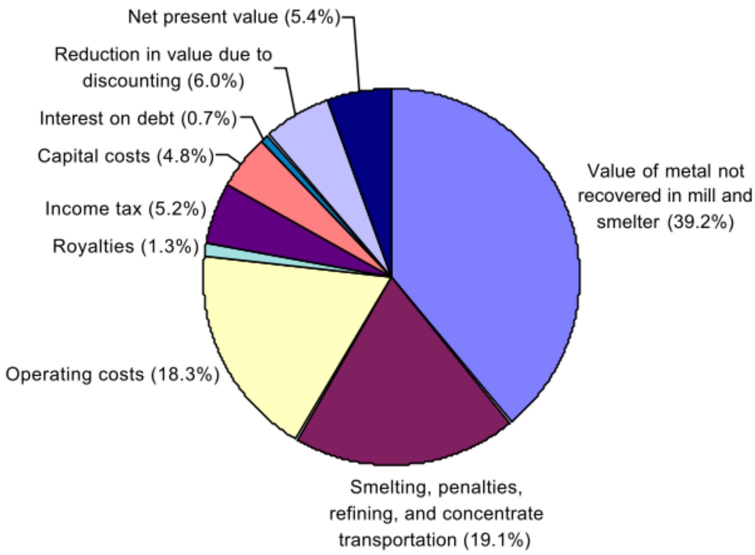
> "The most critical parameter is clearly grade. Low-grade projects are much more sensitive to adverse movements in the commodity price or operating difficulties. The higher the grade, all other factors being equal, the safer the investment."

In fact, within mining circles, the aphorism 'grade is king' is often evoked to underscore the value-relevance of grade. Thus, both the size and grade of a resource are esteemed as leading PVFs within the NRS.

Still, the value-relevance of a resource's parameters can be impeded by other dynamics. In fact, Taylor et al. (2012), in an empirical analysis into the propensity of ASX-listed natural resource firms to disclose information about reserves, found that reserve disclosures are highly variable - and are a function, amongst other factors, of whether the reserves are located overseas and the firms' corporate governance standards. By implication, stated resources may, in some circumstances, not serve as an effective reflection of 'actual' resources. Indeed, companies often only define reserves and resources to sustain production through to the medium term – with further exploration often delineating additional reserves and resources. For example, Baurens (2010) cites the Dome Mine (Ontario, Canada), which at that time had been constantly mined for gold and silver for over 88 years, but whose mine life had never defined beyond three years. Aside from such large resources, smaller economic deposits are also often not represented as quoted resources because their small size does not warrant the expense incurred in proving them-up. Occasionally, for small deposits with expected positive cash-flows, companies may elect to bypass formal resource definition and simply begin mining. Thus, in some cases, particularly for extremely large resources or unusually small deposits, stated resources may not be representative of a company's actual resources.

Moreover, the value-relevance of resource parameters is often superseded by other PVFs. Consider the parameter of in-ground value, itself a PVF, determined by multiplying a resource's grade, size and the market value of the commodity-types contained in that resource (grade ×size×value). Critically, in-ground value must be substantial if it is to easily surpass the generally considerable investment required to develop any mine (Pohl, 2011). Nonetheless, in-ground value has been vilified in some quarters as an overly-simplistic PVF (Lonergan, 2006). Moreover, in-ground value does not account for a host of other PVFs such as the depth of the resource, metallurgical issues associated with extraction and the location of the resource with respect to appropriate infrastructure (Rudenno, 2004; Lonergan, 2006).[50] Indeed Figure 60 illustrates, by way of a hypothetical example that NPV is generally only a minor fraction of the in-ground value (Roberts, 2000).

Figure 60 - Reduction from in-ground value to NPV



Source: Roberts (2000)

[50] Indeed, to resolve the common practice of NRCs touting the in-ground value of their resources on the ASX, and thereby potentially misleading investors, clause 51 of the 2012 edition of the JORC Code henceforth prohibited the reporting of in-ground value in market announcements (Hunt, 2013).

9.4 NPV, Technology and Economic Dynamism

In fact, despite possessing considerable in-ground value, a resource's NPV might actually be negative. Thus, as established in the previous chapter, NPV is superlative because it accounts for and distils the gamut of value-relevant factors. To calculate the NPV for a given resource, the costs of extracting the valuable commodities contained in that resource need to be subtracted from the revenue obtained by selling those commodities on global markets - and discounted for the time value of money. Accordingly, the value of a resource increases when the costs of extraction fall or, equally, when the revenues to be obtained rise. Owing to these forces, resources are effervescent and, with the passage of time, can dissolve and come into being where hitherto none existed with. On this theme, Bridge (2004, p.416) ruminates that:

> "Changing societal demands can create new reserves, while viable reserves can be discovered as a result of changes in the market price and/or costs of extraction. The size, location, and value of workable mineral reserves, therefore, are not static products of geological and mineralogical processes, but are dynamic phenomena derived through continual societal economic appraisal of physical matter. Exploration activity and/or the introduction of technologies that dramatically reduce costs can create mineral reserves in places where, to all practical purposes, none previously existed."

A classic example where advancing technology reduced the costs of extraction and thereby created an abundance of resources where none previously existed concerns the application of carbon-in-pulp and carbon-in-leach technologies to mine low-grade, less than 1 part per million (ppm), gold resources (e.g. these technologies, particularly in Western Australia, were responsible for a burgeoning in the Australian gold industry and a considerable step-up in the nation's gold production during the 1980s (Hogan et al., 2002). Advances in explosive technology is another development credited with the creation of many resources that would otherwise never have been economic. In particular, during the 1960s, ammonium nitrate fuel oil (ANFO, AMEX(TM)) was introduced. This technology enabled a general movement towards open pit mines which were favoured given their economic and safety advantages compared to underground operations.[51] These advantages allowed the development of many resources that, otherwise, would never have been considered resources (Mudd, 2010).

[51] For instance, as noted in the previous chapter, Ferguson et al. (2011) reported that, for a sample of ASX gold-developers, open pit projects were more likely to succeed.

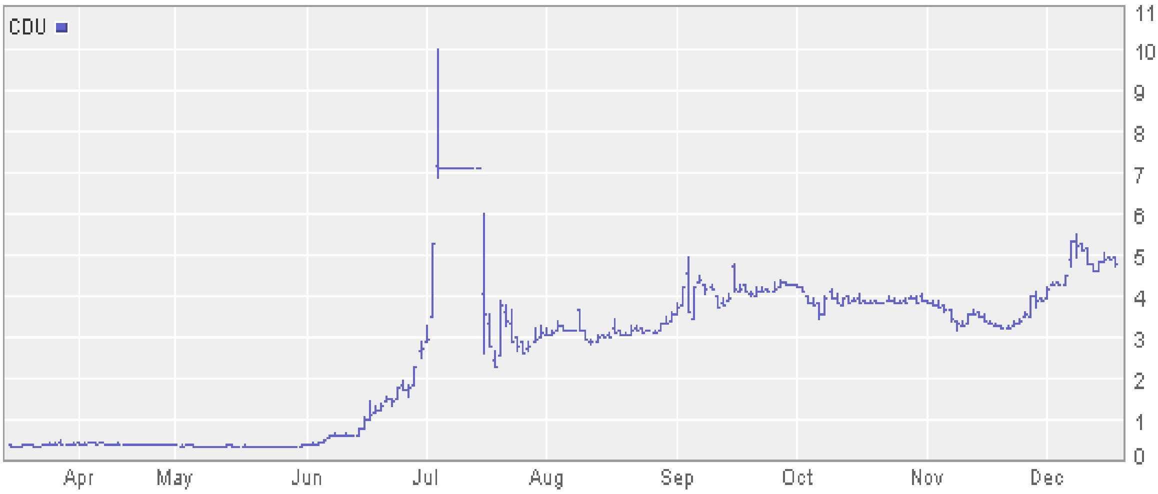
9.5 Metallurgy

Another major PVF for resources, often related to the technological context, concerns metallurgy: specifically, how easily can the valuable commodities enclosed in a resource be separated from the surrounding waste-rock? For example, a gold resource will, ideally, be free-milling – that is, the gold will be of sufficient grain size that it can be won through the relatively simple means of gravity. By contrast, more finely-grained gold can necessitate the use of cyanide leaching which imposes higher plant costs and the need for more stringent environmental safeguards. Even more formidable, with additional costs and potential environmental consequences, is the case of microscopic gold, which requires roasting (oxidisation), prior to leaching (Milham & Craw, 2009 as cited by Pohl, 2011). Another illustration of the importance of metallurgy concerns nickel resources, of which there are two distinct styles of mineralisation: sulphide and laterite. Sulphide resources are generally located deep underground while laterite resources are typically situated close to the surface. Nevertheless, sulphide resources are generally preferred as they are far easier to process from a metallurgical perspective compared to nickel laterites. Indeed Andrew Forrest, the individual generally credited with the dramatic success of the previously discussed Fortescue Metals Group, was ousted from his first major leadership role in the mining industry (CEO of Anaconda Nickel from 1995-2004), following major cost blowouts in the development of a nickel laterite operation, known as Murrin Murrin (Western Australia;(Fullerton, 2002). Thus, whether gold, or nickel or some other commodity-type, the peculiar metallurgical characteristics of a given resource will forcefully shape the complexities and costs involved in its mining, and (as a result), is considered an important PVF.

9.6. A Case Study

Thus, there exists a myriad of PVFs influencing the market's appraisal of resources, in addition to technological developments and metallurgy, some form the subjects of other chapters – for example, a project's stage-of-development and drilling results. Still, despite the myriad of PVFs, the project parameters of grade and size, as previously discussed, typically hold primacy. A dramatic vignette illustrating the import of resource size concerns the case of Australian Mining Investments Limited, an ASX listed NRC. In May/06, shares in the company were trading at approximately 30 cents per share, but began to increase given expectation that its copper resources, located in North West Queensland, were to be substantially upgraded. On 29 Jun/06 trading in the firm closed at $2.20, following a further increase in the share price following the announcement of an inferred copper resource of 59 million tonnes at 2 percent copper for its Las Minerale resource, with expectation of further resource upgrades in the near future. Over the subsequent trading days, shares in the company continued to rapidly increase, and on 5 Jul/06, shares in the company touched $10 – before the ASX suspended trading with the company trading at $7.11 per share. Trading resumed again on 17 Jul/06. Over the blackout period, the company had changed its name to CuDeco Limited.[52] With the reopening of trading on 17 Jul/06, CuDeco Limited announced that the previously declared inferred resource had been overstated, and it actually stood at only 25 million tonnes, the remaining 34 million tonnes could not be classed as an inferred resource under the JORC Code, but rather represented a 'target.' Given the resource downgrade, a large part of the dramatic share price appreciation was erased, with the company closing trading that day at $3.56 per share (Fraser, 2010). The dramatic share price appreciation of Cudeco Limited, over the final three quarters of 2006, including the sharp correction on 17 Jul/06 are depicted in Figure 61.

Figure 61 - Share price performance for Cudeco Limited



Source: ETRADE Australian Securities Ltd (2012)

9.7 Event Studies

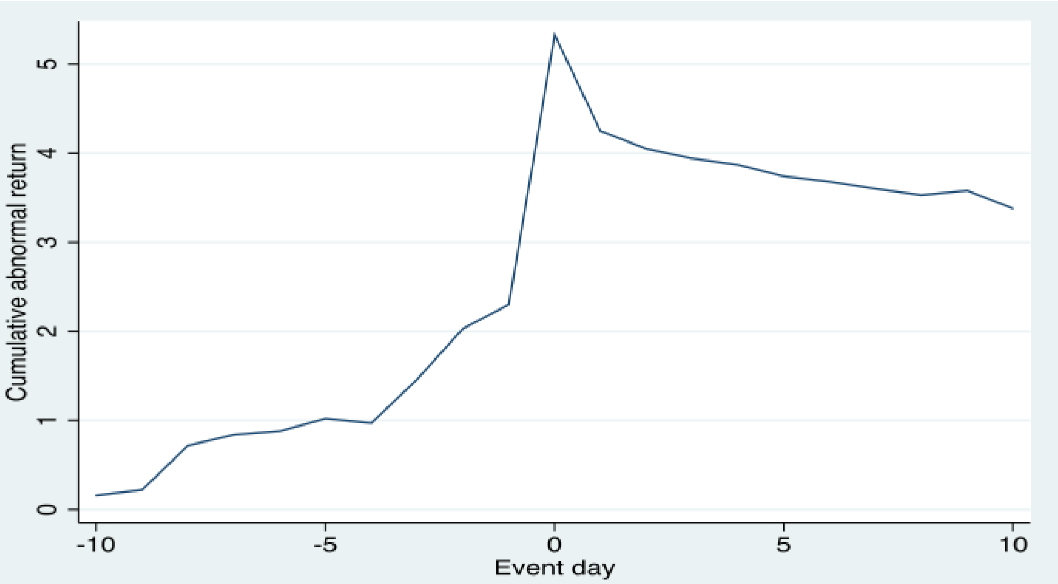
As a climactic case-study of the market dynamics surrounding resource announcements by NRCs, CuDeco Limited is instructive. However more generalizable results are provided by Pündrich (2014), a thesis examining approximately 1,500 resources and reserves disclosures by companies, predominately NRCs, attempting to

[52] The name refers to three elements: (1) *Cu* - from the chemical symbol for copper, (2) *De* – for the 'Deal of the century' and (3) *Co* – for company.

transition those resources and reserves into productive mines. Under an event study methodology, Pündrich (2014) reported significant abnormal returns accruing to companies on the day of resource and reserves announcements, as depicted in Figure 62, underscoring the general contention that resources and reserves are indeed PVFs.

Furthermore, Pündrich (2014) found that larger resource and reserve upgrades tend to be associated with larger abnormal returns. This supports the size of resources as a key PVF. In terms of the confidence attached to these resources and reserves, it was found that inferred resources and probable reserves, lower confidence designations, held the greatest value-relevance. Generally resources and reserves are first designated with a low confidence designation, and, as work progresses, are affirmed with higher confidence designations.

Figure 62 - Cumulative abnormal returns over the 21-day event window

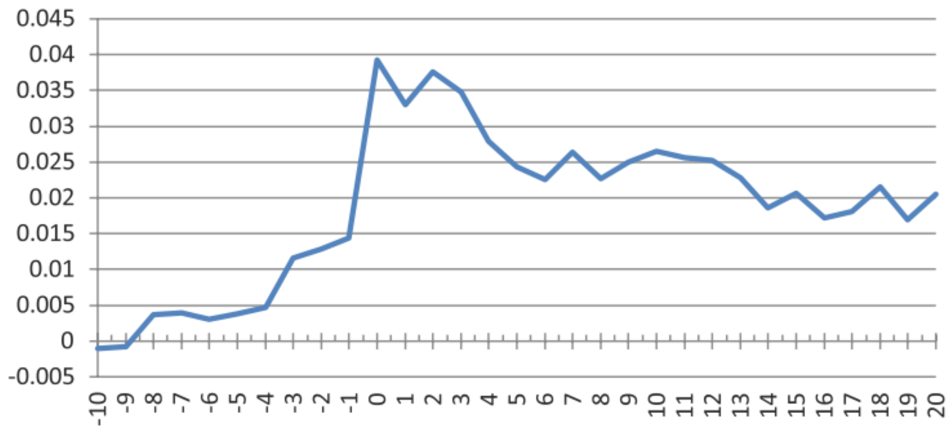


Source: Pündrich (2014)

Thus, low confidence designations are more reflective of long-term production potential while higher confidence designations are more indicative of short to medium-term production. Accordingly, Pündrich's (2014) results suggests that investors place more emphasis on long-term than short-term production potential, when appraising resource announcements. Additionally, Pündrich (2014) found that the reputation of the third-party geological experts who assured the resource and reserve announcements – as proxied by market share and commodity specialisation - was significant.

The Bird et al. (2013) event study examined, in addition to exploration results, the market's reaction to resource and reserve announcements issued on the ASX from Dec/04 to Dec/08. For resource announcements, the sample comprised 678 announcements from 272 unique companies while reserve announcements were rarer, with 99 announcements from 46 unique firms over the four-year study period. Notably, Bird et al.'s (2013) sample was dominated by NRCs, indeed, firms issuing resource announcements held a median market capitalisation of approximately $AUD57 million while those issuing reserve announcements held a median market capitalisation of approximately $AUD202 million. The event window for this research ranged from 10 trading days prior to the announcement to 20 trading days after. Results confirmed, like the work of Pündrich (2014), that the release of resource announcements is highly value-relevant.

Figure 63 - Returns for surrounding resource announcements

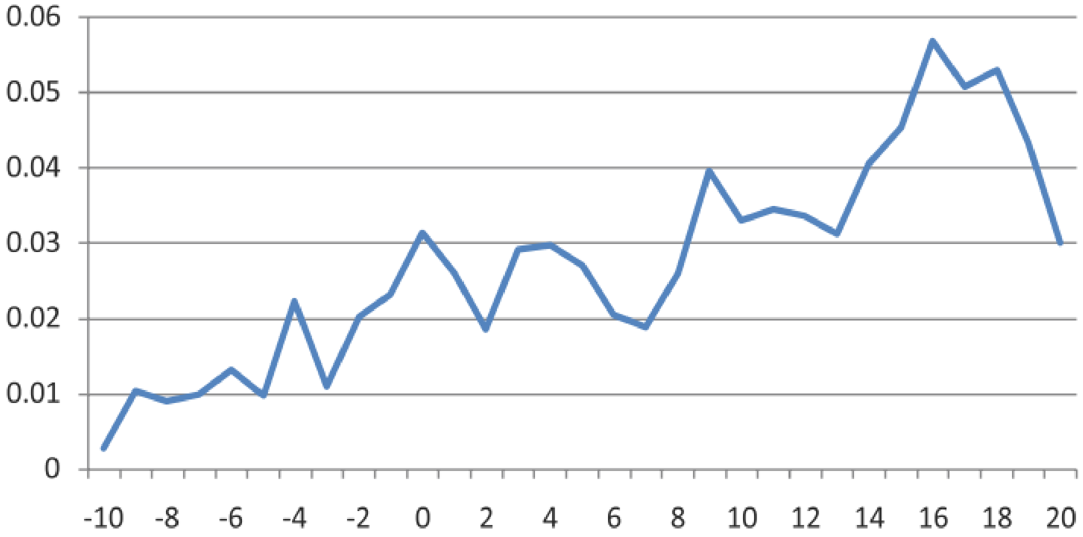


Source: Bird et al. (2013)

Further, there is evidence to suggest that resource announcements are, to some extent, anticipated by the market – with abnormal returns also accruing in the days prior to the announcements release. Bird et al. (2013) assert that this observation may suggest the presence of insider trading. The cumulative abnormal returns for Bird et al.'s (2013) resource announcements, over the event window, are provided in Figure 63.

Multivariate analysis by Bird et al. (2013) on the observed cumulative abnormal returns accruing to resource announcements reveals that, if it was the first resource announcement from the natural resource enterprises, the returns were significantly positive. Furthermore, the percentage increase in the size of the resource, as compared to the previously announced resource, was approaching significance. By contrast, Bird et al. (2013) found that reserve announcements did not significantly impact market value over the event window.

Figure 64 - Returns surrounding reserve announcements



Source: Bird et al. (2013)

Bird et al. (2013) argue that such a finding is sensible, given that reserves were originally resources upon whom, gradually, sufficient work had been undertaken so as to demonstrate that they are feasible to mine, such that they are not really ‘new’. Such an assertion is supported by Pündrich’s (2014) work, discussed above, which confirmed that resources and reserves of lower confidence designations (e.g. inferred resources and probable reserves) held the greatest value-relevance. Albeit insignificant, the cumulative abnormal returns observed by Bird et al. (2013) for the reserve announcements are provided in Figure 64.

9.8 Chapter Summary

Resources and reserves, as the foundation of future earnings, are deemed important PVFs within the NRS. In particular, the designated confidence of a resource, whether the resource has transitioned to reserve status, as well as the chief project parameters, especially grade and size, are all considered PVFs. The pre-eminence of a resource’s NPV was again affirmed in this chapter, and is affected, amongst other factors, by technological developments and metallurgical issues. Moreover, event-studies conducted in the area confirm that resource announcements are value-relevant, with larger resource upgrades, lower resource confidence designations, whether it is the firm’s first resource announcement, and the reputations of third-party geological experts all positively related to cumulative abnormal returns.

Ultimately, resources and reserves are delineated by drilling. Therefore, drilling is an important PVF and will be dealt with in-depth in the next Chapter.

Chapter 10: Drilling Factors

10.1 Chapter Introduction

Resources are first discovered, and subsequently delineated, through drilling. Accordingly, drilling is a vital process throughout the NRC's lifecycle: from nascent, grass-roots exploration through to better defining advanced resources. Irrespective of a NRC's stage-of-development, the ultimate purpose served by drilling is the resolution of uncertainty. By providing resolution to uncertainty, drilling represents, in many respects, the final arbiter of success or failure within the NRS. Thus, drilling is deemed a vital PVF for the NRS and is the focus of this Chapter.

10.2 Resolving Uncertainty

Exploration is considered to be the transformative 'crucial step' in generating value for any project (Lord et al., 2001). To quote J.K. Ellis (1998, as cited by Pohl, 2011, p.416), then Chairman of BHP Australia, "In my view the greatest value is added by the geologist who starts with nothing other than some ideas and goes out into the desert and finds an orebody." However, drilling is not the only indicator of exploration success, other important PVFs include geochemical surveys, geophysics, trenching, and more esoteric methods like biogeochemical and atmospheric sampling (Pohl, 2011). Still, such exploration methodologies are more commonly employed prior to drill-testing, at the earliest stages-of-development. In particular, given large swathes of exploration tenure, these exploration methodologies are employed to isolate exploration 'targets,' that, if considered sufficiently promising, are subsequently validated through the final arbiter of drill testing. Moreover, drilling remains the final arbiter of discovery success because no other method so definitively resolves the uncertainty of the exploration process. Whether a particular drill target represents an orebody or barren rock is, ultimately, a scientific hypothesis; the subterranean realm being, overwhelmingly, a mystery. In this vein, but directed to the academic enterprise, Einstein once quip, "If we knew what we were doing, it wouldn't be called research, would it?" (as quoted in Greenlaw, 2006, p.11). Likewise, in relation to the exploration enterprise, it might be said: 'If we knew where the mother lode was, it wouldn't be called exploration, would it?' Thus, analogous to the academic who theorizes and then empirically tests these theories, the essence of exploration lies in hypothesizing over potential hiding places for resources. In order to test these hypotheses, drilling is conducted; indeed, drill-testing represents the primary means by which such hypotheses are proven. Thus, drill testing remains the sine qua non process to resolve exploration uncertainty.

Nevertheless, drilling only yields knowledge over the particular dimensions of the drill holes; an orebody may be narrowly missed, and the target thus falsely designated as barren: a false negative. Indeed, completely definitive information is often not achieved even for the specific vectors actually tested under a drilling program, with inaccuracies between the actual content of the drilled vector and the results of that drilled vector arising from a variety of sources. For instance, cheaper drilling methods generally provide less accurate results, with reverse circulation drilling providing superior accuracy compared to rotary air blast drilling, while both these drilling methods are trumped by the accuracy of diamond core drilling (Rudenno, 2004). Nevertheless, while imperfect, drilling retains the mantle of chief uncertainty resolver in the NRS as it provides the most definitive sampling method available (Rudenno, 2010).

10.3 Discovery Success

Even holes drilled that fail to encounter mineralisation are valuable, insofar as they increase geological understanding and, moreover, by eliminating an area from the search, help eventually guide a NRC to discovery success. Therefore, NRCs that drill extensively and often, would, all things equal, be expected to hold better prospects for exploration success, and consequently, may support higher market valuations. Trench and Judge (2002, p.88) note:

> "Nothing quite makes an explorer's share price rise like a mineral discovery. To achieve this, an explorer will need to drill holes. It is therefore logical to back those explorers that show evidence of spending a high proportion of their exploration dollars on drilling (or that have persuaded someone else to drill for them on favourable joint venture terms)."

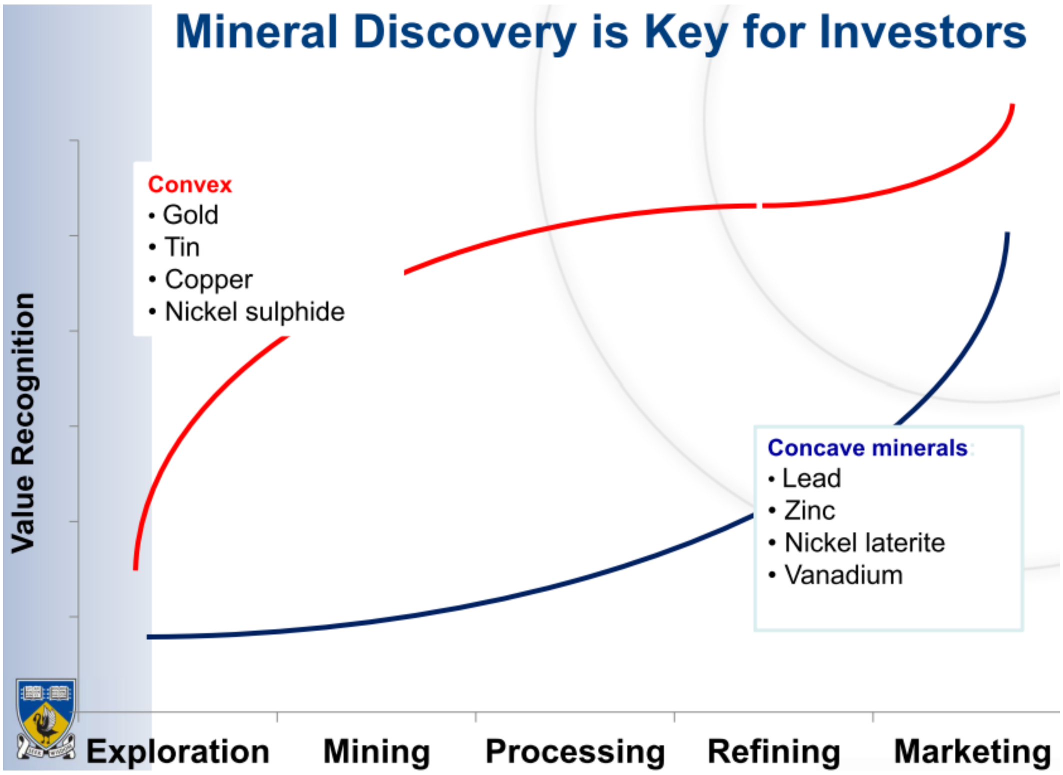
Indeed, Chapter 3, which investigated Accounting Factors, has already recognised exploration expenditures as a PVF under this research. A case-study which has entered mining folklore, and moreover, illustrates that drilling intensity is indeed a PVF, is that of Great Central Mines NL. Led by Joseph Gutnick, Great Central Mines NL discovered the Plutonic Gold Mine in Western Australia in 1988. The discovery followed Joseph Gutnick seeking spiritual advice from the Rebbe Menachem Schneerson in New York City following heavy losses in the 1987 stock market crash. The Rebbe advised Gutnick to return to the Australian outback where he prophesised that he would discover diamonds and gold which would rival the great mines of South Africa – even going so far as to direct Gutnick to the precise location (Long, 2003;Hawthorne, 2008). Inspired, Gutnick returned, and, in a drilling program that one geologist described as, “They're turning the outback into Swiss cheese,” discovered the Plutonic Gold Mine (Hawthorne, 2008). In order to keep Great Central Mines NL afloat, the Plutonic Gold Mine was sold and, with finances replenished, the company went on to discover the Bronzewing Gold Mine in 1992 in the penultimate drill hole of a 65 hole program. The discovery of the Jundee Gold Mine shortly thereafter (Hawthorne, 2008). Thus, extensive drill-testing is likely a factor in eventual discovery success and, thereby, market value.

The importance of drilling as a PVF in the NRS is underscored by the fact that the valuation of most NRCs is exploration-based: the chief hope for a NRC being the discovery of a quality resource – the proverbial ‘company maker’. Indeed, Brown and Burdekin (2000) analogise such exploration-focussed NRCs to an out-of-the-money call option: where the valuation is based upon the NRC’s chances, albeit slim, of discovering a quality resource. Moreover, NRCs hold limited cash reserves and must, generally, draw heavily upon these reserves in order to conduct drill-testing. In the event that these drilling results are disappointing, the NRC may struggle to attract new capital and thus fall prey to insolvency. Thus, as in the case of Great Central Mines NL, NRCs are often under immense pressure to succeed in a timely fashion, before withering cash reserves are depleted. Such time pressures are also a common feature of out-of-the-money call options, where it arrives in the form of expiration dates, beyond which the desired price rise is too late. Consequently, exploration-focussed NRCs may be conceptualised as out-of-the-money call options, with drilling the deciding factor on whether these ‘options’ will expire out-of-the-money or in-the-money.

10.4 Drilling Results

It is contended that the value the market attaches to a drilling result is, primarily, a function of: 1) the commodity-type intersected, 2) the average grade of the commodity intersected and, 3) the length of the intersection (Rudenno, 2010; Lonergan, 2006). Grade and the length intersected are, respectively, indicative of a potential resource’s grade and size and, as such, both grade and the length intersected are deemed PVFs. Meanwhile, the commodity-type intersected is considered a PVF because, as emphasised by Trench and Packey (2012), most value creation occurs upon discovery for certain commodity-types whereas, for other commodity-types, most value creation occurs at a much later stage-of-development (Trench and Packey, 2012). Specifically, some commodity-types are relatively simple to develop into a mine once they are discovered, and, accordingly, most value-accretion occurs on discovery. Examples include gold, coking and thermal coal, nickel sulphide and diamonds. By contrast, some commodity-types are relatively challenging to develop into a mine and, accordingly, most value-accretion occurs as developmental milestones are successfully met. Examples include nickel laterite, cobalt, magnetite and molybdenum. Trench and Packey (2012) connote the former commodity-types as 'convex,' in that most value is created at the discovery stage, whereas the latter commodity-types are referred to as 'concave,' with most value created upon successful development. The differential value-accretion owing to convex and concave commodity-types, according to stage-of-development, is illustrated in Figure 65. Thus, in addition to grade and the length of intersection, this study recognises the value-relevance of mineral commodity-type in the market's appraisal of drilling results.

Figure 65 – Convex and concave commodity-types

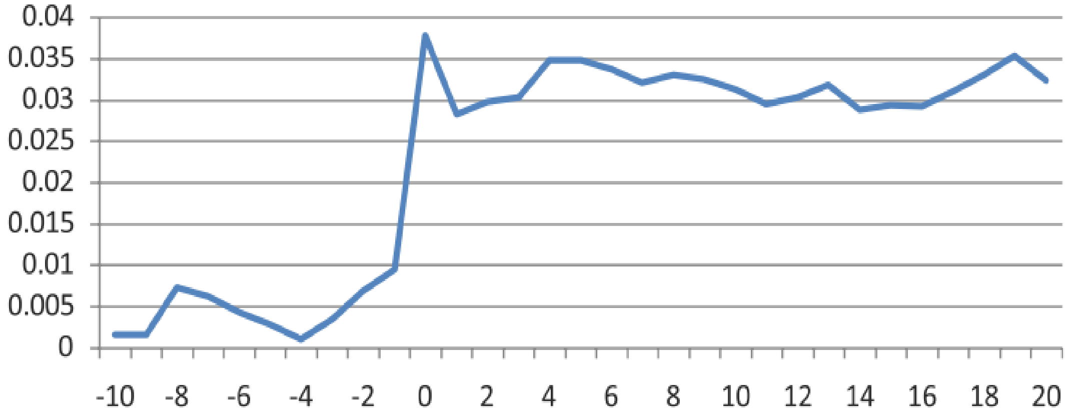


Source: Trench and Packey (2012)

10.5 An Event Study

The value-relevance of drilling is empirically supported by the work of Bird et al. (2013), an event study discussed in the last chapter which, in addition to resource and reserve announcements, also studied the impact of exploration announcements on market value for ASX-listed companies. Importantly, Bird et al.'s (2013) sample was mostly composed of NRCs – indeed, the median market capitalisation of companies announcing exploration results in the sample was approximately AUD$33 million. Specifically, the sample comprised 1,378 exploration announcements from 307 unique companies issued between December 2004 and December 2008. Furthermore, the event window was set from 10 trading days before the announced exploration results through to 20 trading days after the announcement. Notably, these announcements did not only comprise drilling results, but also other kinds of exploration results, such as geochemical and geophysical survey results. Nonetheless, the results confirm that the exploration results are significantly value-relevant with the announcements eliciting a strong price response. The cumulative abnormal returns are presented in Figure 66 over the event window.

Figure 66 - Cumulative abnormal returns surrounding exploration results



Source: Bird et al. (2013)

Moreover, Bird et al. (2013) conducted multivariate analysis and found that positive abnormal returns were especially strong for firms with smaller market capitalisations and for those with more liquidity in the period leading up to the announcement. In addition, similar to resource announcements, there appears to be a degree of insider trading (i.e. a significant portion of the price response occurs before the exploration announcements are actually released). Furthermore, Bird et al. (2013) found that exploration announcements that included positive adjectives in their title, such as ‘bonanza’ or ‘tremendous’, enjoyed significantly higher abnormal returns. This finding is especially interesting as, by contrast, the use of positive adjectives in resource announcements was not significant. Bird et al. (2013) attributed this irregularity to the fact that exploration results are much more difficult to interpret and quantify compared to resource statements. Accordingly, given the higher uncertainty associated with the exploration results, the market is more likely to be influenced by subjective factors, like the use of positive adjectives in the announcement’s title.

10.6 Macroeconomic Conditions

Moreover, the value which the market affords to drilling results is often intensified or tempered by the prevailing macroeconomic conditions—Coulson (2008, p.224) notes:

> "…in a mining bull market even ordinary drilling results can be greeted with unwarranted enthusiasm, end if the market is really hot downright dull results can receive a mystifyingly positive welcome also. In stark contrast, in a mining bear market you could find King Solomon's Mines themselves without raising the remotest investor enthusiasm."

Nevertheless, given the long-lead times involved in transitioning a discovery into a mine, the value-relevance of current macroeconomic conditions is somewhat questionable. Consequently, this research considers the influence of macroeconomic conditions on the market's appraisal of drilling results as a manifestation of speculation. Still, this research recognises the macro-economy as providing important context in determining the value elicited by the content of drilling results.

10.7 Chapter Summary

In summary, drilling is considered a leading PVF within the NRS, especially given that most companies in the sector are focussed upon exploration. In fact, exploration-focussed NRCs can be analogised to out-of-the-money call option. Moreover, drill testing is the ultimate tool by which NRCs resolve exploration uncertainty and thereby create value. Three primary PVFs associated with drilling results were identified, namely: 1) the commodity-type intersected, 2) the grade, and 3) the length of the inter-section. Event-study research has also affirmed the value-relevance of exploration results more broadly, with announcements containing positive adjectives in their titles, firms with smaller market capitalisations, and higher liquidity levels preceding the announcement all positively related to cumulative abnormal returns. Moreover, it is noted that the value-relevance imparted by the content of drilling results is regulated by prevailing macroeconomic conditions.

Yet another factor impacting the value-relevance of drilling results is the specific project where the drilling results occurred. Value-relevant factors relating to projects are the subject of the following Chapter.

Chapter 11: Project Factors

11.1 Chapter Introduction

In general terms, a NRC's value is based upon expectations of its future cash flows, in particular, those sourced through the medium of mining operations. In turn, the basis of mining operations lies in successful resource developments. Resources, in turn, are the product of successful drilling campaigns – the subject of the previous chapter. A common feature of mines, resources and drilling results are that all occur within geographic domains. Projects – areas of geographic space granting certain legal rights to natural resources contained within their boundaries – are thus fundamental to the valuation of all NRCs, irrespective of stage-of-development. Indeed, a NRC with projects, but without the benefit of either mines, resources or promising drilling results is still valuable because, its projects hold the *potential* for mines, resources and promising drilling results. Consequently, the unique value proposition of a NRC is largely a product of the projects it holds, as these represent an effective monopoly over the resources, both discovered and undiscovered, housed within those projects (Trench & Judge, 2002). To this end, this Chapter considers PVFs associated with projects in the NRS.

11.2 A Portfolio of Projects

Typically, a NRC will hold a portfolio of projects – capturing a mixture of geographical domains, commodity-types and stages-of-development. Research by Kreuzer et al. (2007), noted earlier, found that NRCs listing on the ASX hold an average of 5 projects; most of which are at the earliest stages-of-exploration, although there was typically a flagship project with targets awaiting drill-testing within the first year of listing. As noted in Chapter 5, NRCs generally operate with limited resources such that one or a few flagship projects are usually chosen to receive the lion share of a company's resources and attention - often a necessity if meaningful progress is to be achieved. Meanwhile, other projects are put on the 'back-burner' – with only minimum legally mandated expenditures incurred to retain these projects. Still, it is not uncommon for such 'shadow projects' to supplant flagship projects, if, for example, a commodity-type that a shadow project is prospective for suddenly becomes a market darling. Kennedy (1996, p.283), based upon a sample of 220 newly listed NRCs on the ASX, found that the best performers operated a project portfolio that was, "neither very focussed nor very broad." This suggests that the most successful NRCs seek an optimal balance between the benefits of a limited project portfolio (improved focus and lower expenditures given there is not a superfluous number of shadow projects to maintain) and, equally, the benefits of a larger project portfolio (the increased possibility that, given the dynamic nature of the NRS, a shadow project will, by good fortune, attract the market's attention – an opportunity that management, who already hold the project, can quickly capitalise upon).

11.3 Valuing Projects

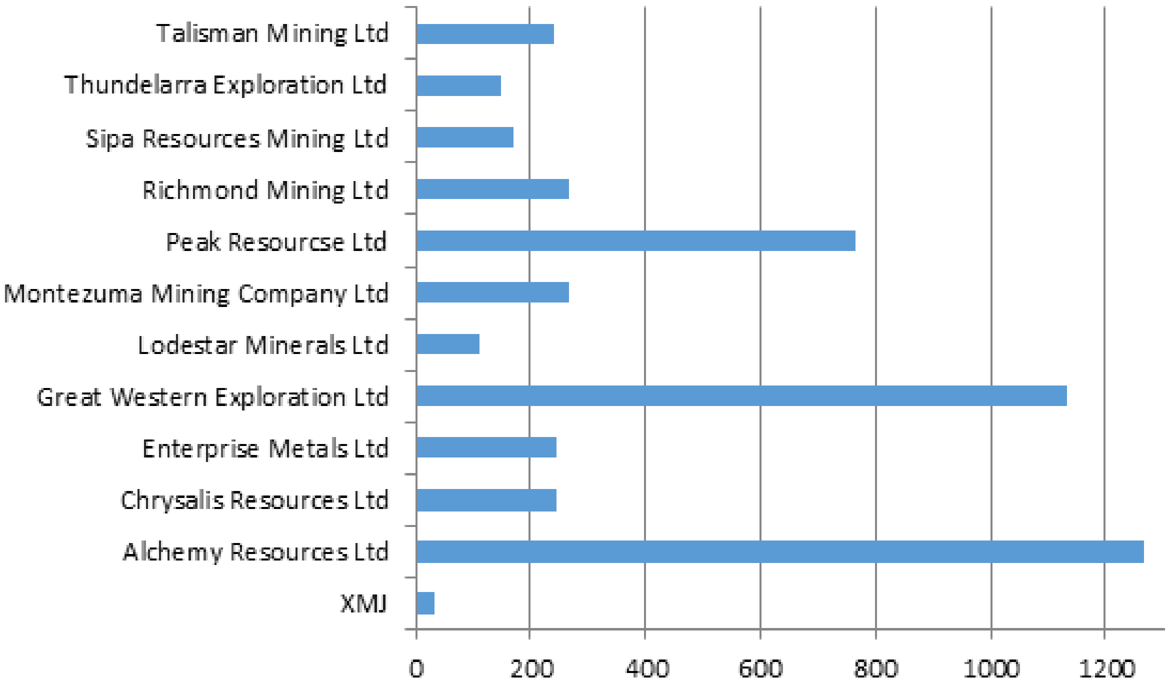
Ultimately, a NRC's market value is a function of its project portfolio. Moreover, each project in the portfolio holds a value, itself a function of the mines, resources and promising drill results contained in the project. Aside from mines, resources and promising drilling results a project also holds inherent value due to its exploration potential. Accordingly, the market value afforded to a project's exploration potential is most easily estimable in the case of NRC's with a single or small number of projects, none of which hold mines, resources or promising drilling results. The market's appraisal of a project's exploration potential can flow from a wide variety of sources, for instance, promising geochemical survey results or a novel geological interpretation that suggests new exploration possibilities. Moreover, a leading PVF informing a project's exploration potential is its geographic location, given that some locations are considered more geologically prospective than others. In particular, certain geological indicators attendant to a location – such as the presence of auspicious faults or volcanic systems – influence the prospectivity of a project. Moreover, projects located in a region known for mines and resources are generally especially valued for their exploration potential. In this vein Pohl (2011, p.418) evokes the geological maxim, "if you wish to hunt elephants, go to elephant country." A parallel adage, commonly espoused as shrewd stratagem within the NRS, is exploring, "in the shadow of the headframe" (Torrey, 2002).

11.4 Nearology

The importance of neighbouring mines and resources to the market's appraisal of an exploration project is evident in the phenomenon of 'nearology'. Indeed nearology is a common means by which a NRC's shadow projects, being maintained with just minimal expenditures, can yet elicit market attention to the point where company management performs an about-face and elevates the project to flagship status. Nearology occurs when a company makes a significant discovery, which not only serves as a catalyst for its own market valuation, but also triggers a material appreciation in the market valuations of companies holding neighbouring projects (Trench & Judge, 2002). At its root, nearology as a phenomenon is due to the fact that economic ore bodies often cluster in close geographical proximity and/or cross tenement boundaries.

An example of nearology occurred following the mid-2009 discovery of the copper-gold Degrussa resource in Western Australia by Sandfire Resources NL. The Degrussa deposit was classed as a volcanogenic massive-sulphide-style deposit, a significant conclusion as this style of deposit often occurs in clusters (Evans & Moon, 2006). As a result the prospectivity of the exploration acreage surrounding the Degrussa discovery improved markedly. The market response to this improved regional exploration potential was witnessed by the fact that those firms holding projects in the immediate area at the time of the discovery, or those who pegged such projects shortly after the discovery, experienced (relative to all market benchmarks) a dramatic appreciation in market value. Figure 67 illustrates the strength of this appreciation for eleven NRCs captured by the Sandfire nearology phenomenon, alongside the performance of a wider ASX materials index (the XMJ Index) of which they are members (C. Iddon, 2010) . The change in market valuation is calculated from 18 May 2009, when the Degrussa discovery was first announced to the market, to 31 December 2009, a period of time over which the significance of the Degrussa discovery gradually became more apparent. Pointedly, the 11 companies captured by the nearology phenomenon increased by 412.75 percent (simple average) while the wider XMJ index increased 34.43 percent over the same period.

Figure 67 - 'Nearology' following Sandfire Resources NL's discovery



Source: Iddon (2010)

Another study investigating the nearology phenomena is the previously cited work of Ferguson and Crockett (2003), which focussed on a 1996 gold discovery by Helix Resources (an ASX-listed NRC) in South Australia. In particular, the abnormal returns accruing to companies with projects in the discovery's neighbourhood were considered in terms of: 1) the distance of these companies' projects from the discovery, 2) the number of projects these companies held in the region, 3) the area these companies projects captured in the region, and 4) the number of times the press cited these firms following the discovery. The study found that the number of press citations following the discovery, and the distance of these firms' tenements from the discovery, were both significantly related to abnormal returns. The latter finding underscores the importance of nearology, with projects closest to the discovery epicentre enjoying the greatest market value uplift.

11.5 Infrastructure Availability

Aside from nearology potential, the location of a project is also deemed a PVF because it controls the attractiveness of the project with respect to available infrastructure. In particular, the value of any resource is ultimately nought if it is not economic to transport the resource's output to market. Notably, when the cost of constructing needed infrastructure is prohibitive – such that the resource cannot be transitioned into a reserve - the resource is designated as a 'stranded asset.' This is especially pertinent for commodity-types of low per unit value that are necessarily produced in large volume to achieve the necessary economies of scale. Consider the case of BC Iron Limited, a NRC listed on the ASX, reported in 2009 a 50.7 million direct shipping ore (DSO) iron resource for its Nullagine Iron Ore Project located in the Pilbara region of Western Australia. Nonetheless, this resource represented a stranded asset, as the economics of the project were insufficient to justify the construction of a standalone rail facility. However, BC Iron entered an agreement with the previously discussed Fortescue Metals Group to employ their rail and port facility to develop the project. Consequently, the 'de-stranded' Nullagine Iron Ore resource was classifiable as a 'reserve' (Bennison, 2012a). Thus, a project's location is value-relevant because it defines the availability of infrastructure and, thereby, the cost of transporting mined output to market.

11.6 Inter-Project Synergies

The case of BC Iron Limited illustrates a larger point: the value affixed to a project is not determined in isolation, but can also be a function of the relationship between projects. In particular, synergies are often available, where agreement can be reached, between the projects of otherwise competing companies. Moreover, even when cross-company collaboration is unavailable, the value of a NRC's project portfolio is generally more than the sum of its parts; that is, aside from the aggregated value of each individual project, additional value is often created by the synergy of the overall portfolio of projects. For example, a portfolio of projects in close geographical proximity may produce operational efficiencies by reduce the time and associated costs for geologists and other field staff to travel between projects. Similarly, by restricting a portfolio of projects to a single nation or jurisdiction – a NRC can leverage its existing contacts and knowledge of the relevant legal context when, for example, acquiring a new project.

11.7 Diversification

Thus, in determining the value afforded to a NRC by its projects, the individual value of each project needs to be considered, as well as the value produced by the portfolio of projects itself. In particular, a project portfolio confers the benefits of diversification. By definition, NRCs do not enjoy the level of diversification of the major resource houses, but, nevertheless, NRCs insofar as their portfolio of projects is diversified, do enjoy some measure of the benefits to accrue from diversification. For instance, NRCs may hold projects prospective for different commodity-types and thus, in the event that the price for one of these commodity-types were too decline substantially, be somewhat buffered. Similarly, while NRCs holding a portfolio of transnational projects will probably not enjoy the same operational efficiencies won by their more geographically focussed peers, they will potentially benefit by diversifying some measure of the sovereign risk to which they are heir.

11.8 Sovereign Risk

Indeed, diversification of sovereign risk is deemed an important PVF. National governments differ markedly in terms of their support of private enterprise and foreign investment in the resources industry. Moreover, international diversification of projects defines the degree of risk inherent in the portfolio given the variability in legislative activities between countries. Sovereign risk can manifest in extreme forms such as the appropriation of a private resource company's assets by the state or in more subtle forms (e.g. nuanced alterations to the tax code). Godoy (1985, p.201 & 202) emphasises the point that, ultimately, companies, especially those at an advanced stage-of-development, are often beholden/hostage to the national governments in whose jurisdictions they operate:

> "In mining, as in marriage, after one party makes an irrevocable first move, the other faces a reduced incentive to abide by the contract. Once a miner or a multinational corporation (MNC) sinks investments in a successful exploration venture, property holders or host nations have incentives to evict them or nationalize the venture.…With fixed investments sunk, the conditions are ripe and the incentives are large for host nations to confiscate the holdings of mining firms."

Thus, due to the immobility of natural resources, NRCs, and their larger peers, are, especially vulnerable to sovereign risk. A recent manifestation of sovereign risk came in September 2011, when President Hugo Chávez, enacted law-decree 8413, which effectively nationalised all gold mines across Venezuela (Hoddinott & Smith, 2012). Godoy (1985) mentions an earlier South American example: the nationalisation of Chile's copper industry following the rise to power of Allende in the early 1970s. Nevertheless, sovereign risk is a function of government policy and so changeable with successive governments. Indeed Chile is now one of the most liberalised nations in the world, suppling approximately 40 percent of the world's copper, with many NRCs and larger resources houses successfully operating there.

In fact, research by Bridge (2004) has examined the general move towards liberalisation by many developing nations in the 1980s and 1990s and the impact his has had on investment in the natural resources industry. Specifically, Bridge (2004) acknowledges that such liberalisation has generally worked to ameliorate sovereign risk by (for instance) clarifying tenement and ownership policies regarding the development of resources. Bird (2004) found that liberalisation was relevant, but that its relevance was predicated upon the broader macroeconomic cycle. In particular, traditional mining nations received relatively constant levels of investment throughout the cycle; whereas those developing nations that adopted liberalising policies benefited from increased investment flows, but the improved investment flows were only observed during the buoyant phase of the cycle. Bridge (2004, p.418) thus concludes:

> "…liberalizing economies may act as 'swing targets' for investment. Such targets receive greater proportions of investment at times when increases in mineral prices and/or the availability of project financing allows greater levels of risk to be tolerated, but are preferentially drained when the availability of funds decreases."

11.9 Location

Further empirical evidence for the value-relevance of location, from a trans-national perspective, is supplied by Roberts' (2000) citation of a 1999 Deutsche Bank Securities study that found, for a given gold price and discount rate, North American gold producers traded at an average premium to NAV of 53 percent; whereas, Australian and South African producers traded at, respectively, 17 and 19 percent discounts. The value-relevance of location is also supported by Kennedy (1996) on a state-by-state level. Under her study's sample of NRCs, companies with operations focussed in Western Australia performed, ceteris paribus, better. In addition Kennedy (1996) reported that NRCs with operations overseas and in the Australia state of Victoria suffered lower internal rates of return. Kennedy (1996) surmised that this might have reflected home bias or overseas risk, and, in the case of Victoria, higher developmental costs.

11.10 Chapter Summary

In summary, this chapter recognises the value-relevance of projects, over and above, the mining and resource assets, or drilling results, circumscribed within their boundaries. In particular, projects hold exploration potential and thereby value. Exploration potential is found to be, in large measure, informed by a project's location. In particular, project location determines the availability of infrastructure and the known endowment of mines and resources in a region. The value-relevance of regional mines and resources is seen to be especially topical in the event of nearology. Moreover, the value of any one project is not determined in isolation, but is affected by its environment and relationship to other projects. Therefore synergies between projects and, through the project portfolio, the diversification of risk (especially sovereign risk) are also PVFs influencing the market's valuation of a NRC's projects.

This Chapter, along with its predecessors, have identified those PVFs of significance to the NRS. Thus, the groundwork has been laid for the following Chapter, Chapter 12, where all the PVFs identified under this work are mapped into a conceptual framework. It is the objective of this conceptual framework to explain the process by which the market imputes value in the NRS.

Chapter 12: A Conceptual Framework for NRC Market Valuation

12.1 Chapter Introduction

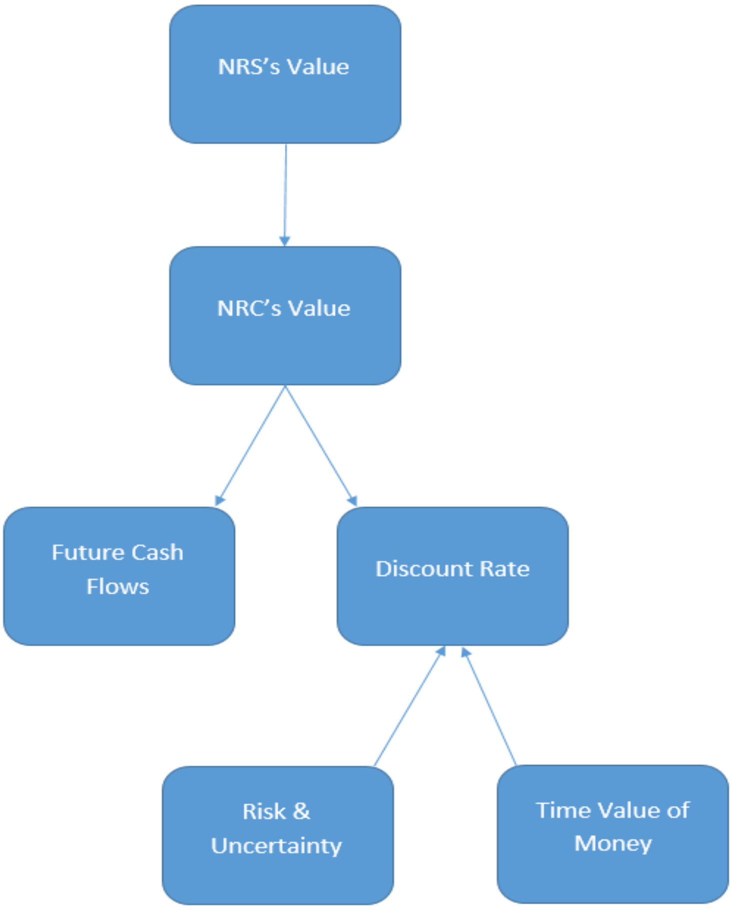
Having previously identified PVFs of consequence to the NRS, this Chapter creates the capstone of the research by organising the identified PVFs into a conceptual framework of valuation for the NRS. By providing a conceptual framework explaining the process by which the market imputes values to NRCs, this Chapter contributes to resolving the general mystery surrounding market valuation in the NRS. Accordingly, by the conclusion of this Chapter, the primary research question of this research (How does the market value NRCs?) will be addressed. To this end, the offered conceptual framework is both novel and unified and, thereby, contributes to ameliorating the dearth of research considering market value in the NRS from a comprehensive perspective. Specifically, the conceptual framework by subsuming key PVFs suggested by the received literature, illustrates the manner in which these PVFs interact to define market valuation in the NRS. In addition to the literature, the conceptual framework to follow is defined by the empirical analyses conducted according to this research which examined the value-relevance of accounting-based PVFs, SEO-based PVFs, as well as the PVF of commodity prices which served as the medium to assess the value-relevance of macroeconomic context. Under this research, a PVF is a factor that can, at least conceivably, influence expected cash flows or uncertainty/risk. The only qualification to this definition being that the factor, in accord with the tradition of fundamental analysis, must lend itself to systematic analysis – that is, it or its proxy must be quantifiable.

12.2 A Conceptual Framework

Given the definition of PVFs, the following conceptual framework is founded in the fundamental notion of finance that the value of any asset is the product of its future cash flows discounted for the time value of money and for the risks and uncertainties associated with these cash flows (see, for instance Fisher, 1930; Parker, 1968). Moreover, it has been emphasised throughout this work that, insofar as the NRS is concerned, valuation is bedevilled by gross uncertainty in many things, including future earnings. Thus, especially for NRCs at an early stage-of-development, many PVFs (such as maiden drilling results from a grass-roots exploration prospect) provide little more than blurred intimations and mere inklings of future earnings. Nonetheless, the market, for want of more definite information and certainty, will employ what PVFs are readily available – albeit with a larger discount, given the often extreme uncertainty involved in such PVFs.

Accordingly, this basic tenant of finance upon whose foundation this research is constructed is expressed in Flowchart 1. Notably, Flowchart 1 represents the first of eight flowcharts that, taken together, captures the conceptual framework developed under this research.

Flowchart 1 - Valuation in the NRS

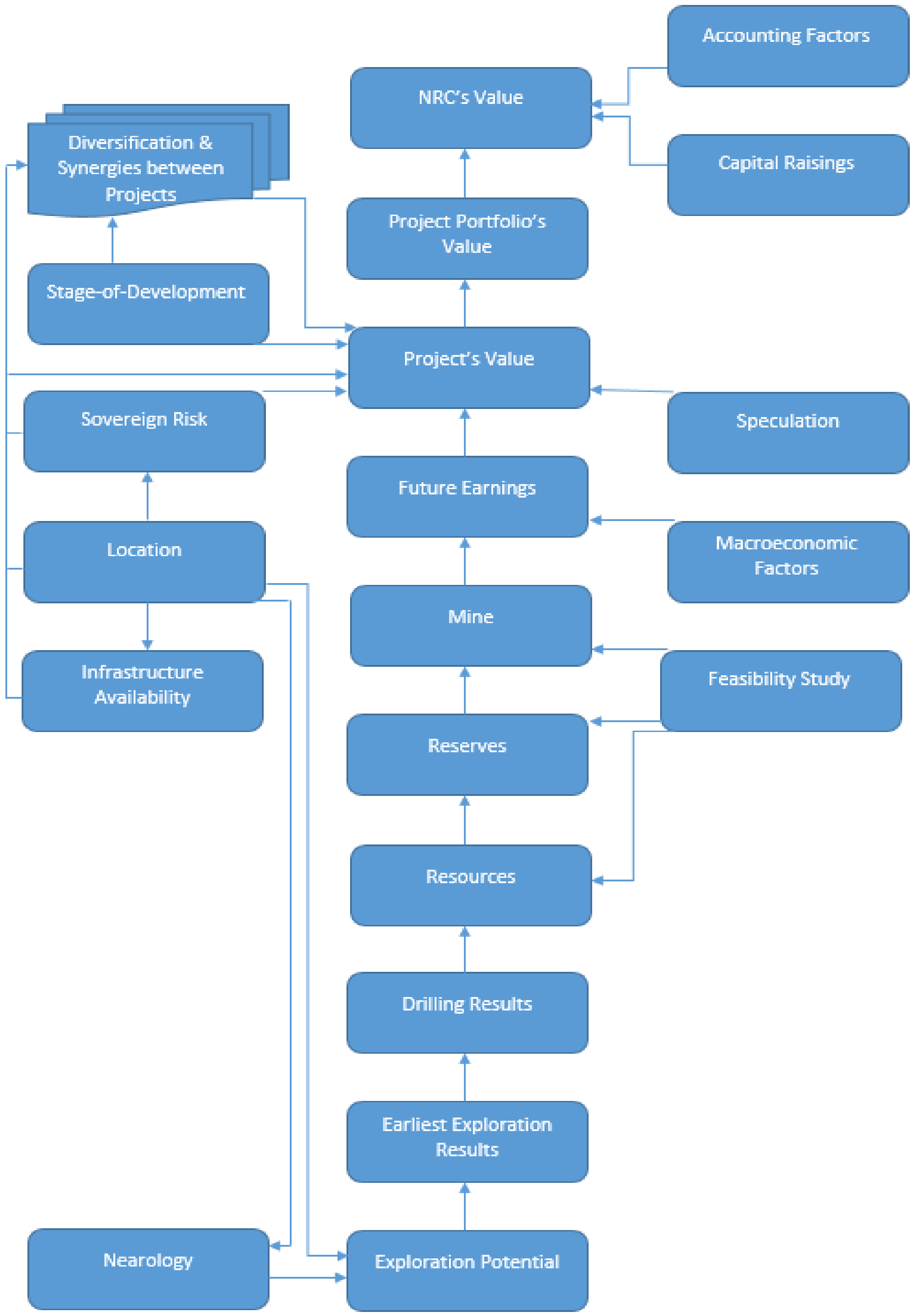


In Flowchart 1, as in all the ten flowcharts that comprise this research's conceptual framework as illustrated in this Chapter, a connecting arrow is employed to designate a relationship between two PVFs, such that, the PVF pointed to is a 'function of' the PVF from which the arrow originates. Thus, to represent 'B' as a function of 'A', the following representation would be employed:

A ⟶ B

Accordingly, Flowchart 1 represents the fact that the aggregate market value of the NRS is a function, specifically a summation, of the market values of all the NRCs that comprise the sector. In turn, the value of a NRC is considered a function of the discounted future cash flows expected to accrue to the company. The extent of discounting applied to these future cash flows is itself a product of the risk and uncertainties associated with these cash flows as well as the time value of money, such that cash flows expected to arrive in the more distant future are discounted to a greater extent than those cash flows expected in the shorter term.

Flowchart 2 – Market's valuation of a NRC



In Flowchart 1, NRCs are the elemental unit of value in the NRS. In turn, under this research, a natural resource project is deemed the elemental unit of value comprising a NRC. This is because a project is the legal mechanism by which a company holds rights over all future earnings to be derived from its mining operations. Accordingly, Flowchart 2 depicts all the broad categories of PVFs considered, under this research, to determine the market's value of a project. Notably, while this research deems projects to be the fundamental unit of value to a NRC, a NRC usually holds more than a single project. Specifically, given the uncertainties and risks beleaguering the sector, NRCs tend to hold a portfolio of projects. Thus, as per Flowchart 2, a NRC's market value is considered the product of its portfolio of projects, the value of this portfolio being a function of the individual projects comprising it. Still, aside from project-based PVFs, there exist two 'corporate' categories of PVFs held to directly impact the market value of NRCs under Flowchart 2, namely accounting PVFs and capital raising PVFs.

Under the business model of the NRS, the objective is to discover, develop and operate mines – mines representing the promise of future earnings for NRCs and, therefore, the fundamental basis of all value for the sector. Accordingly, the value of a project is considered a function of the future earnings to be won on the project through mining operations. The future earnings to be derived from mining operations are, in turn, impacted by macroeconomic factors. Flowchart 2 also denotes speculation as another factor, regardless of a project's future earnings base, as another PVF that can directly impact the market's appraisal of a given project.

In addition, Flowchart 2 illustrates the point that mining operations are ultimately derived from reserves. Reserves, meanwhile, are the product of resources. Moreover, Flowchart 2 recognises that the creation of mines, reserves and resources are all, fundamentally, a product of successful feasibility studies. Still, anticipating mines, reserves and resources are drilling results, given that the discovery and delineation of resources depend upon successful drilling campaigns. Still, it is important to note that drill testing will never proceed unless earlier phase exploration results, like geochemical and geophysical surveys, are promising enough to actually define a target in the first place. In fact, even such early phase exploration efforts will never be performed unless an area is considered of sufficient exploration potential.

As per Flowchart 2, a project's exploration potential is largely a product of its location, with some locations being considered geologically favourable to the existence of resources or already have known/historical mines and resources *in situ*. Consequently, new discoveries in proximity to a project can elicit market reappraisal of a project's exploration potential, as evidenced by the phenomenon of nearology. Indeed, nearology apportions market value to other NRCs in the region as a spatial function. Thus, nearology itself is a key element in valuing location.

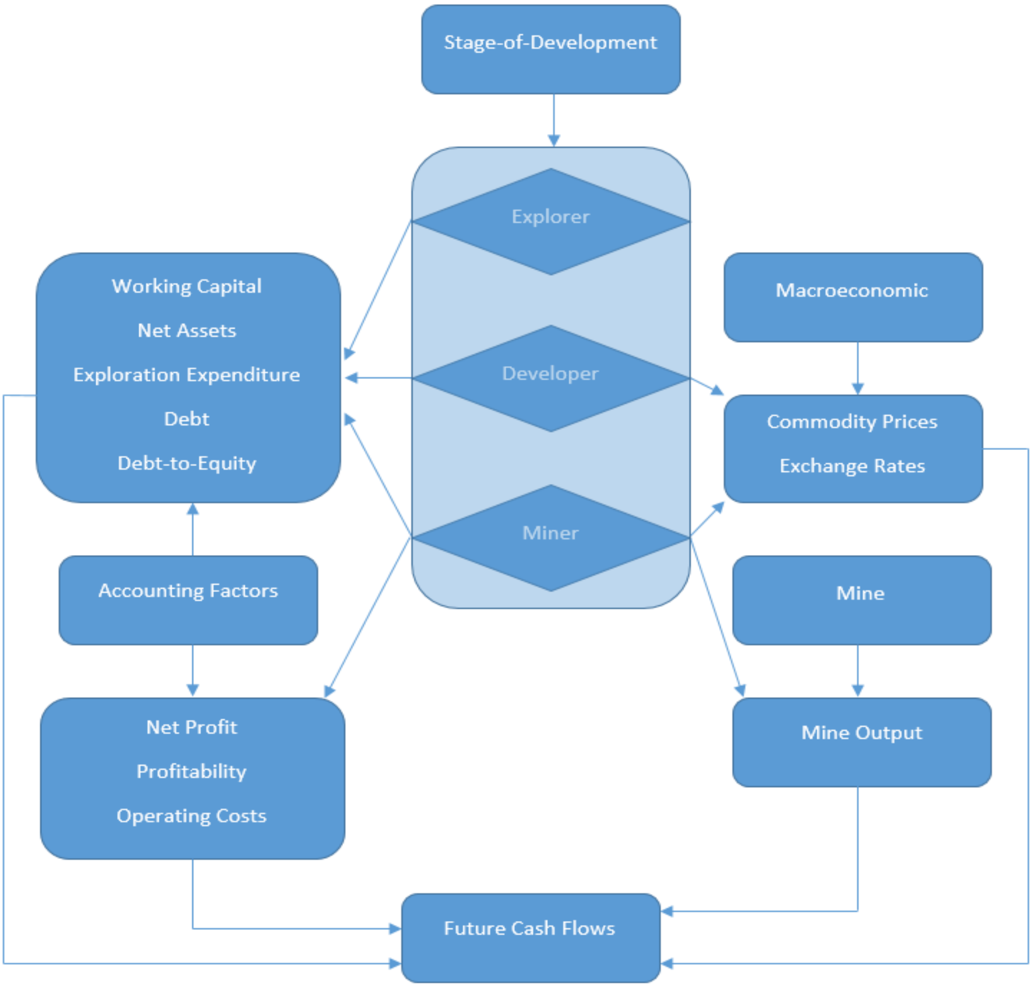
Other PVFs contributing to the value of location include sovereign risk and infrastructure availability. Moreover, given that NRCs generally hold a portfolio of projects, and given that projects normally occur in locales where other NRCs hold projects, the value of any project is partly a product of the potent potential of synergies and diversification bestowed by other projects. Indeed, infrastructure availability and sovereign risk largely define the potential for such synergies and diversification, through for instance, availing the infrastructure of an otherwise rival company, or, by diversifying the heightened sovereign risk associated with a particular nation by holding projects in other nations more supportive of the extractive industries.

Stage-of-development is another factor considered to directly influence a project's value under Flowchart 2. Stage-of-development is also an important factor determining the market's appraisal of synergies and diversification benefits that accrue to a given project due to the existence of other projects (e.g. drawing on the previous example, the diversification benefit and associated valuation premium provided to a NRC who holds projects in both safe and risky nations from a sovereign risk standpoint will largely depend upon stage-of-development). Thus, if a NRC's flagship project is at an advanced stage-of-development but located in a high-risk business environment, and the company holds other projects in relatively safe business environments all at a nascent stage-of-development, than the potential awards that the market might otherwise attribute to this sovereign risk diversification will be greatly diminished.

Flowchart 2 captures the spectrum of PVFs considered to influence the market's appraisal of NRCs. As noted, aside from accounting and capital raising based factors, these PVFs are rooted in a NRC's project portfolio. Notably, some of the PVFs included in Flowchart 2 are very broad, like, speculation and accounting PVFs, whereas others are more specific, like nearology. In fact, Flowchart 2 represents the heart of this research, in that it highlights, in an all-inclusive manner, all of the PVFs, and their interactions, that together produce market value in the NRS.

In the interests of clarity and presentation, especially for broad categories of PVFs, Flowchart 2 omits many details uncovered in this work. Accordingly, the remaining six flowcharts of this Chapter highlight in greater detail and context particular PVFs only broadly identified in Flowchart 2. In particular, the six flowcharts to follow are loosely reflected in chapters 3 to 10 of this work such that each flowchart is based on a particular category of PVF. The primary difference being that the flowcharts to follow explicitly express the interactions between PVFs – including the important contextual interactions imparted by other categories of PVFs. Further, the flowcharts to follow are drawn from both this work's literature review as well as its empirical findings. Thus, the remaining six flowcharts further draw out particular PVFs identified in Flowchart 2 and in the process effectively map the PVFs and their cross-relationships that coalesce to define market value in the NRS.

Flowchart 3 – Accounting PVFs



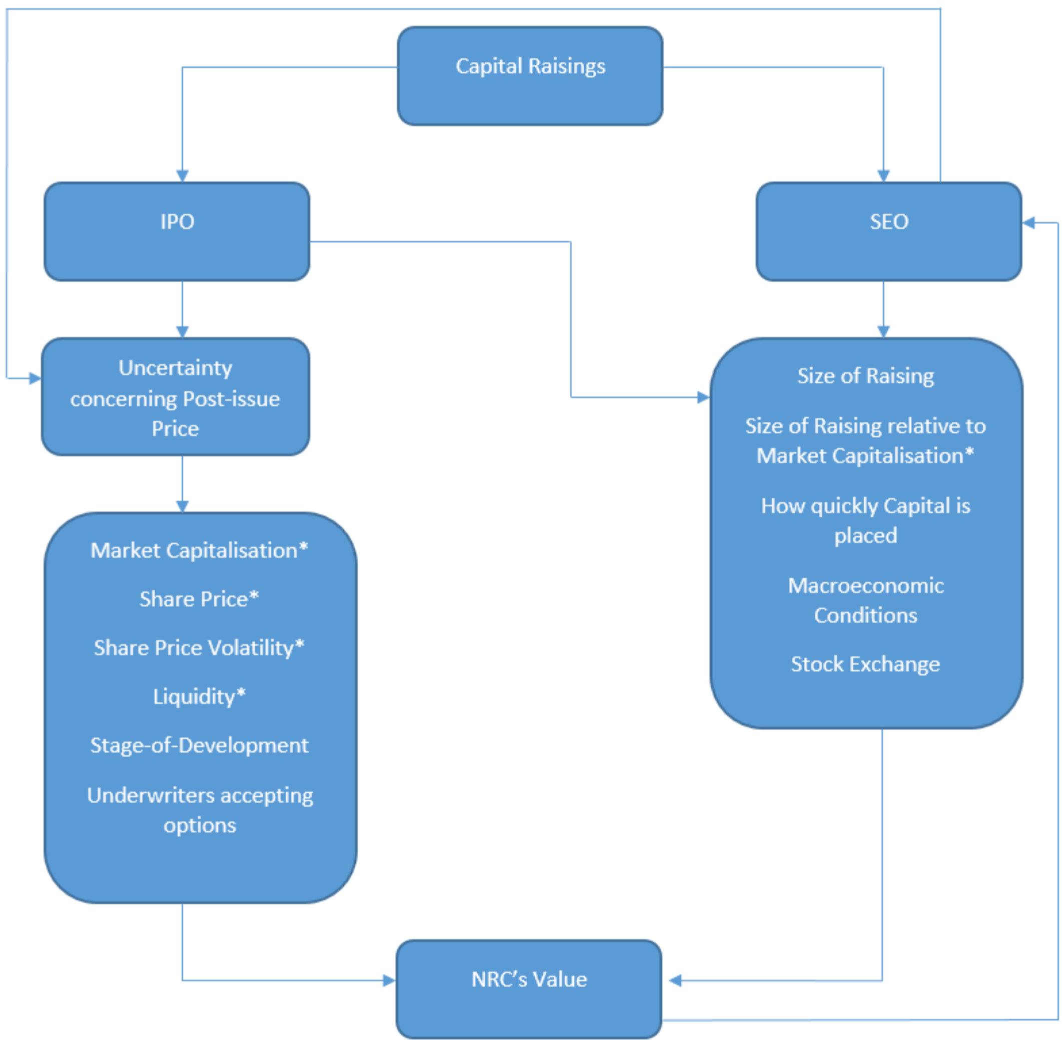
Flowchart 3 focuses on accounting-based PVFs. Similarly, each of the following flowcharts focus on a different aspect of Flowchart 2 concerns. Under Flowchart 2, accounting-based PVFs are held to directly impact the market's valuation of NRCs. More specifically, accounting-based PVFs suggest future cash flows, and thereby the market's valuation of NRCs. Accordingly, Flowchart 3 explains how accounting-based PVFs interact, in the context of other pertinent PVFs, to suggest a NRC's future cash flows.

Conspicuously, Flowchart 3 emphasises that the value-relevance afforded to accounting-based PVFs are largely a product stage-of-development. In particular, for the case of NRCs with operational mines, net profit, profitability and operating costs are all considered PVFs as they communicate the value being produced by the mine. Meanwhile, other accounting-based PVFs are considered value-relevant irrespective of stage-of-development, in particular: working capital, net assets, exploration expenditure, debt and debt-to-equity. Moreover, non-accounting based PVFs illustrated under Flowchart 3 include the importance of macroeconomic factors – particularly commodity prices and exchange rates - to NRCs with operational mines or those developing mines and for whom production is foreseeable. Indeed, the empirical work conducted under herein has affirmed the significant value-relevance of commodity prices. Another non-accounting PVF signalled as important for NRC's operating mines, as per Flowchart 3, is the amount of output of a mine. In particular, NRCs with low net profits may still enjoy high market valuations, if mine output is high. This is because high mine output imposes less constraint on revenues and, thus, provides a large scope for higher profits if commodity prices or exchange rates move favourably or operating costs are reduced.

Despite Flowchart 3, the empirical research conducted under this work failed to find any significant value-relevant accounting factors. Nonetheless, these findings were impacted by a number of limitations including omitted variable bias, in particular, a failure to control for stage-of-development. Indeed, Flowchart 3 emphasises stage-of-development as a major contextualising factor in determining the value-relevance of many accounting-based PVFs. For instance, net profit is considered of value-relevance for producers, for whom higher net profits would generally translate into higher market valuations. However, net profit is not an appropriate performance metric for exploration or development focussed NRCs. Consequently, for the sample of NRCs tested under this research, the value-relevance of net profits for producers, who only comprise a minority of the NRS, may have been negated by the preponderance and explorers and developers for whom net profit is not value-relevant. Still, the statistical insignificance for working capital, net assets, exploration expenditure, debt and debt-to-equity is more troublesome for the value-relevance of accounting information, and suggests that the value-relevance of accounting PVFs may simply be too small relative to the extremely noising market pricing that characterises the sector.

Aside from accounting PVFs, the other corporate category of PVFs concerns capital raisings, of which, there are two distinct forms (IPOs and SEOs; see Flowchart 4). Given that there is no public market in a company's shares prior to listing, certain PVFs associated with the antecedent capital raising period are not applicable to IPOs (e.g. share price, share price volatility, liquidity and market capitalisation are not calculable for IPOs prior to listing). PVFs which apply to SEOs but not to IPOs, are denoted in Flowchart 4 by an asterisk.

Flowchart 4 - Capital raising PVFs

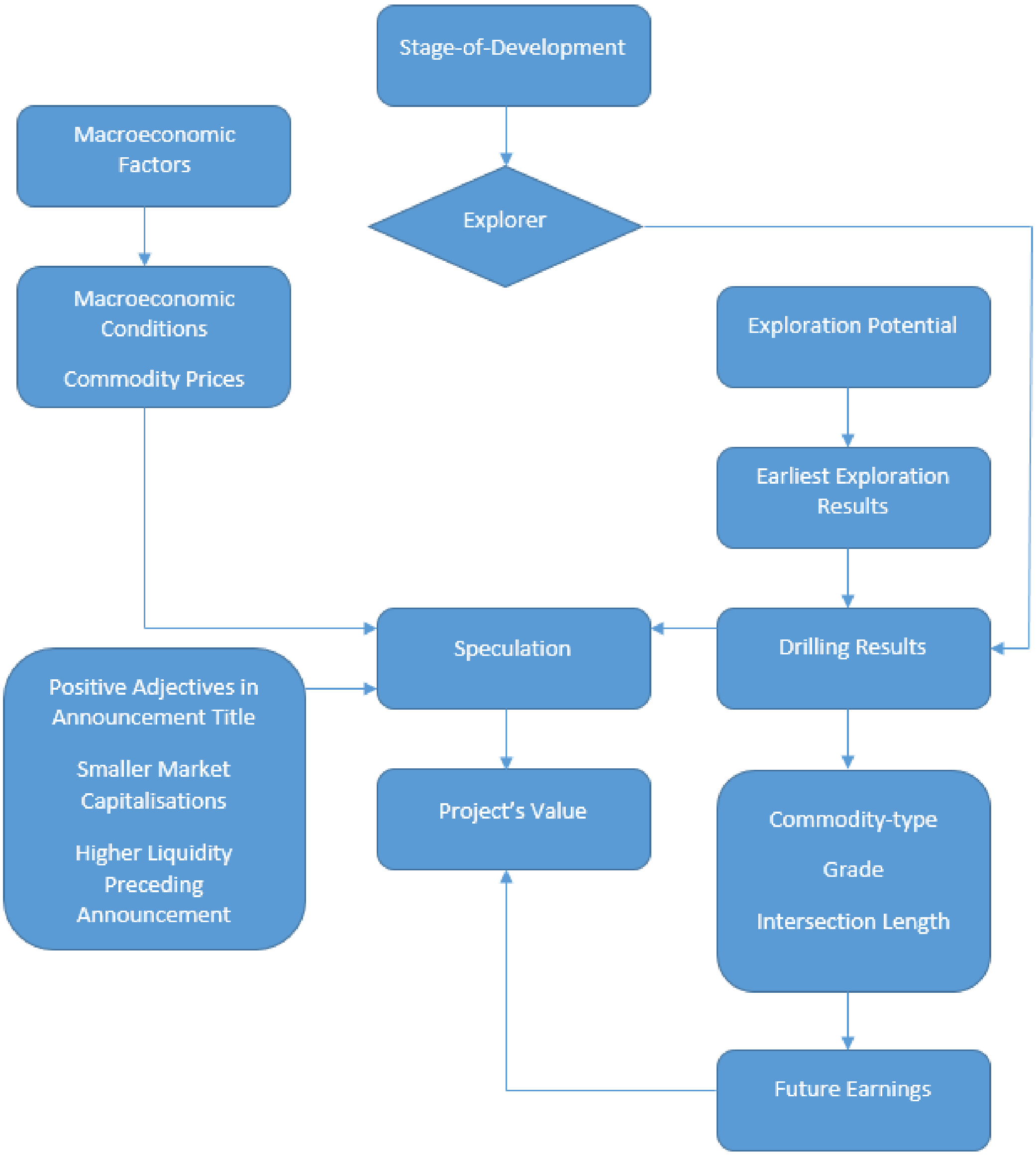


Flowchart 4 denotes the point that, in broad terms, the PVFs for IPOs, under this research, are considered synonymous with those for SEOs. This similarity reflects the common capital raising function served by both IPO and SEO, where capital raisings are held to influence the market value by allowing, or inhibiting, the investment inflows that NRCs generally rely upon to execute their business model. The capacity to raise money at attractive rates is considered, in large measure, a function of uncertainty concerning post-issue market price, where this uncertainty is proxied by several PVFs (e.g. share price, share price volatile, market capitalisation, liquidity, stage-of-development and whether underwriters accept options). Other PVFs included under this research include the size of the raising, the size of the raising relative to market capitalisation, the speed at which capital is placed, prevailing macroeconomic conditions and stock exchange.

Notably, SEOs hold a special place in the conceptual framework espoused in this Chapter, due to a feedback loop where SEOs influences market value—similar to an ordinary PVF, but where market value (in turn) also influences SEOs. This is unusual, given that most PVFs influence market value in unidirectional fashion, whereas, in the case of SEOs market prices also influences SEOs. Specifically, as demonstrated by the empirical research conducted herein, SEOs are generally preceded by several months of cumulative abnormal returns. Accordingly, a NRC's market value, in particular sustained market outperformance, supports the issue of SEOs. Furthermore, the empirical research conducted under this work found that abnormal returns preceding SEOs were positively related to the size of the SEO relative to the NRC's market capitalisation, and negatively related to liquidity. While market pricing following SEOs is not generally abnormal, there was some evidence that certain exchanges did promote under or out-performance in the post-issue period. In addition, there was weaker evidence that, following SEOs, the size of the capital raising relative to the market capitalisation was again a significant PVF positively related to abnormal returns.

While accounting and capital raising factors are deemed independent of a NRC's project portfolio, the subject of Flowchart 5, speculation and, relatedly, drilling results, is held to directly impact the market's appraisal of a resource project.

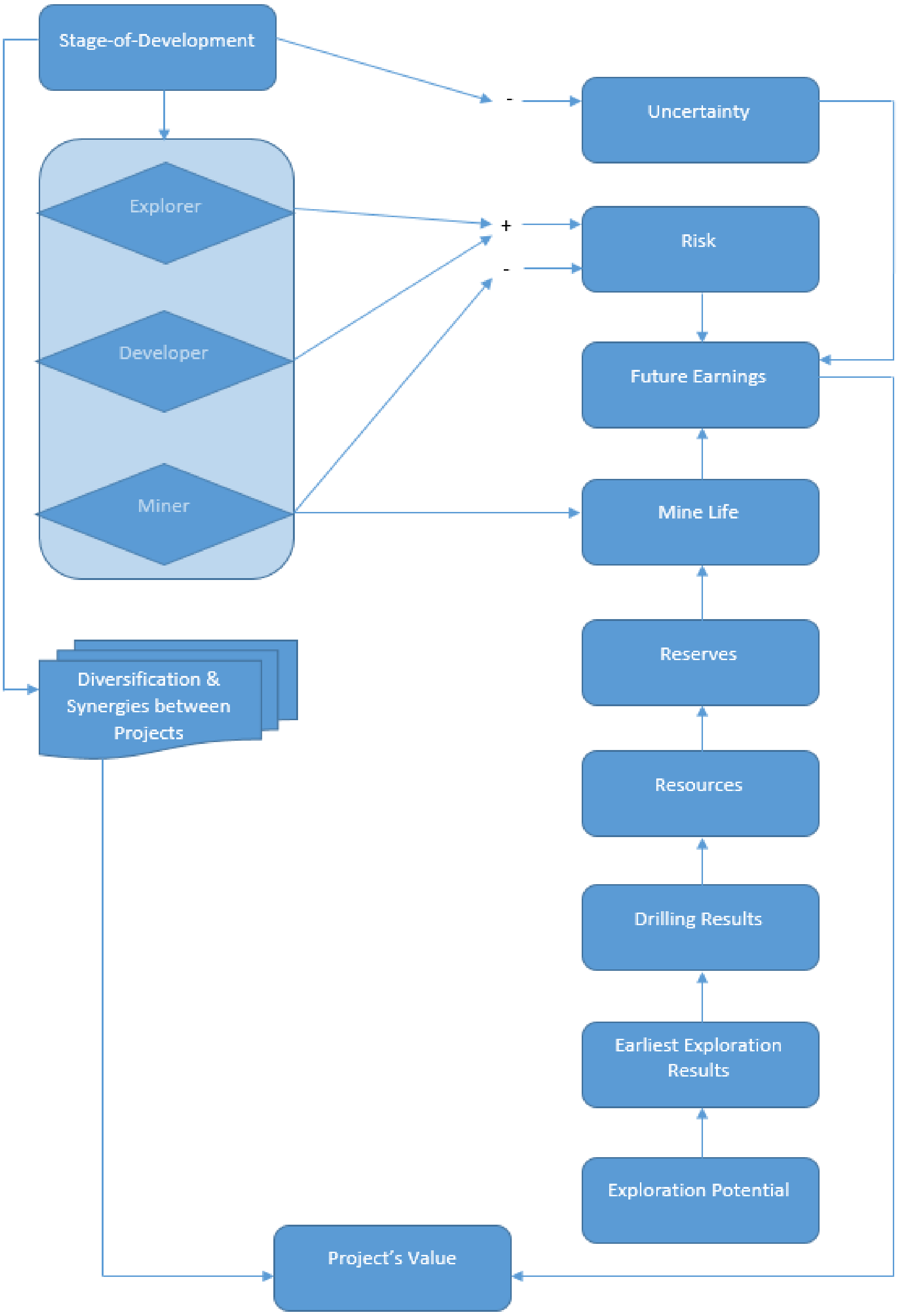
Flowchart 5 - Speculation and drilling result PVFs



In particular, Flowchart 5 demonstrates that speculation is supported by stage-of-development, with NRCs at the earliest exploration stage-of-development releasing drilling results particularly likely to foster speculation. Speculation is also supported by macroeconomic conditions, especially commodity prices, and by NRC's with smaller market capitalisations and higher liquidity levels preceding the announcement of drilling results. Also, the employment of positive adjectives in the announcement title of drilling results is considered to support speculation. Meanwhile, drilling results, motivated by a project's exploration potential and subsequently promising early exploration results, are considered informative in ways that are not related to speculation. Specifically, objective consideration of commodity-type, grade and the length of intersections are considered PVFs influencing future earnings, and, thereby, a project's value.

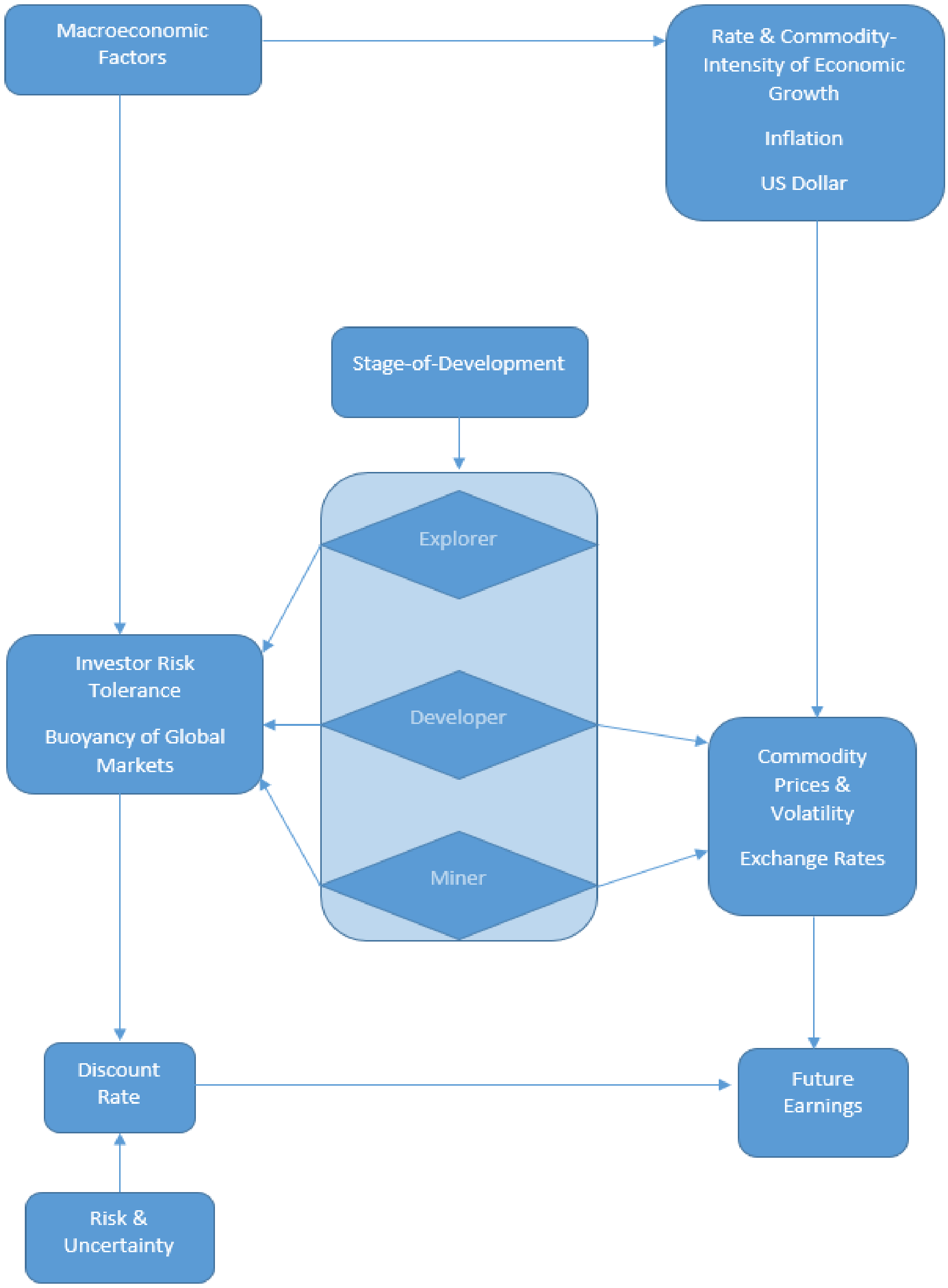
Flowchart 6 focuses upon stage-of-development which, like speculation and drilling results, is held to directly impact the market valuation of a project. Further, as discussed in Flowchart 2, stage-of-development informs the diversification and synergy possibilities available via other projects, which, in turn, also impacts project value.

Flowchart 6 - Stage-of-development PVFs



In particular, as per Trench's (2012) dichotomy of risk, stage-of-development defines the uncertainty and corporate risk associated with a given project. Specifically, there is a negative relationship between stage-of-development and uncertainty, such that the uncertainty associated with a project declines as stage-of-development advances. In contrast, corporate risk is positively related to stage-of-development up until, or just prior to, the commencement of mining where it declines, thereafter. There is generally a positive relationship between market value and stage-of-development up, until the commencement of mining, from which point market value is often steadily declines.

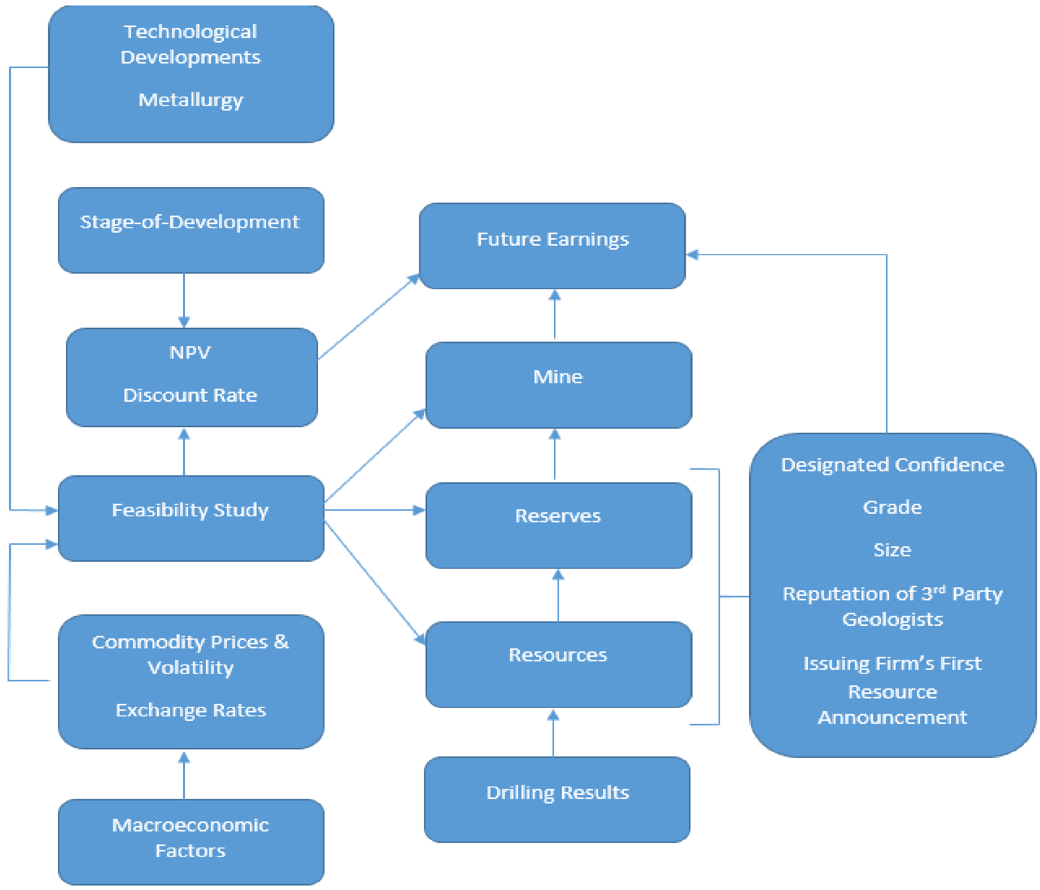
Flowchart 7 - Macroeconomic PVFs



This decline is a product of mine-life, as production continues mine life, and thus future earnings, progressively diminish—unless something promises to extend mine-life, namely new reserves, resources, drilling results, earliest exploration results or even a project's exploration potential all can act to disrupt the otherwise negative relationship between market value and the advancement of mining operations. Stage-of-development also relates to Flowchart 7 – which focusses upon macroeconomic PVFs.

Macroeconomic PVFs are contextualised by stage-of-development, with commodity prices and commodity-price volatility, as well as exchange rates, of relevance to miners and advanced mining developments. Commodity prices, commodity price volatility, and exchange rates are, in turn, all functions of even more fundamental macroeconomic PVFs, including the rate and commodity-intensity of global economic growth, inflation and the US dollar. Still, other macroeconomic PVFs, namely investor risk tolerances and, relatedly, the buoyancy of global equity markets, are not predicated on stage-of-development. Rather, investor risk tolerances and the buoyancy of global equity markets broadly influence the discount rate applied to the uncertainties and risks applied to future earnings regardless of a NRC's stage-of-development. Macroeconomic PVFs are also a feature of Flowchart 8, which encapsulates PVFs to arise from both feasibility studies and resources given their close association.

Flowchart 8 - Resource and feasibility study PVFs



Specifically, commodity prices, commodity price volatility and exchange rates flow into feasibility studies—particularly the chief outputs of a feasibility study (NPV and discount rate). Also influencing the outcomes of feasibility studies, are metallurgical issues, the current state of technological development and stage-of-development. NPV and discount rates are vital in suggesting future earnings – with the confidence placed in these metrics rapidly mounting with stage-of-development. Moreover, feasibility studies are foundational in the creation of resources, reserves and mines; all of which impact future earnings. PVFs associated with resources impacting future earnings and associated confidence in those earnings include a resource's designated confidence, grade, size, the reputation of the third-party geologists and whether it is the first resource announcement by a firm.

12.3 Chapter Summary

Consequently, the eight flowcharts presented in this chapter, based upon this work's literature review and empirical findings, represent the mechanisms by which the market determines value in the NRS. Indeed, these eight flowcharts, taken together, express the conceptual framework developed under this research and the method by which the market employs PVFs, in combination, to decide the market value of NRCs.

The conceptual framework is based on the fundamental precept of finance that the value of an asset is the outcome of its future cash flows discounted for risk and uncertainty. While founded in this precept, many PVFs comprising the conceptual framework lie outside the traditional boundaries of DCF analysis. This is largely a product of the immense uncertainties permeating the sector, which often render financial and probability projections redundant, and place the emphasis on more qualitative and imaginative factors. Thus, the conceptual framework reveals the scope of PVFs and their rich interactions that together, coalesce to form market values in the NRS.

The succeeding Chapter concludes the thesis, considering the gap in the literature that was addressed, the contribution to knowledge, limitations to the research as well as possibilities for future research.

Chapter 13: Conclusion

This thesis has focussed on the question of market value insofar as the NRS is concerned. The NRS is a critical component of the global economy: functioning as a key resources font for the wider natural resources industry – the industry tasked with supplying the vast majority of physical inputs required by the global economy. Despite the NRS's importance, the means by which the market imputes valuations within the sector is notoriously enigmatic. This thesis has endeavoured to help unravel this enigma. The purpose of this Chapter is to conclude the thesis such that the reader may judge the success and extent to which this work has contributed towards alleviating the mysteries vexing valuation in the NRS.

This Chapter is structured by: first, invoking the gap in the literature that motivated the work; then, the research questions which ensued are considered; after-which, the research methodology engaged to help answer these questions is discussed; then, the findings to emerge via this methodology are reflected on; and, the work's contribution to knowledge is advocated; finally, limitations to the research are noted and opportunities for future research are suggested.

13.1 Research Gap, Questions and Methods

As emphasised, the process by which NRCs are valued in equity markets is widely acknowledged (by the literature) to remain, in large measure, an enigma—traditional valuation methodologies employed elsewhere appear inadequate in explaining market value in the NRS. It is the position of this work that the maintenance of the enigma is largely due to the dearth of valuations-research focussed on the NRS and adopting a comprehensive and systematic perspective. Specifically, the limited literature pertaining to valuation within the NRS resembles a patchwork of foci with little attempt to weave these disparate research efforts into an integrated account of market valuation for the sector. Thus, to address this research gap, this study undertook a comprehensive and systematic investigation of the process by which the market imputes valuations for NRCs. To this end, the primary research question guiding this study is broad-based, and is as follows:

How does the market value NRCs?

In seeking to answer this primary research question, two subsidiary research were constructed, namely:

1. What are the PVFs within the NRS suggested by the literature?
2. How do the PVFs interrelate in context to determine the market value of NRCs?

Importantly, given the broad nature of these research questions, the methodology employed was, by necessity, similarly comprehensive in its scope. Accordingly, a mixed methods approach was employed (melding qualitative and quantitative research) to explain market value in the NRS. Aside from the mixed methods approach, this work also accepted and was directed by the fundamental analysis tradition. Notably, so as to not unduly constrain the research, PVFs were defined with intentional latitude: including 'any' factor suggested by the literature that might influence the market's appraisal of NRCs—as long as, that factor lends itself to systematic identification (i.e. quantifiable).[53]

Pointedly, to address the first of the two subsidiary questions, the literature was reviewed (Chapters 3 to 11) in order to identify PVFs. In complement to this literature review, a number of PVFs were empirically tested to either confirm or disconfirm their validity in practise (Chapters 3 and 4). Thereafter, the second of the two subsidiary research questions was addressed (Chapter 12)—through developing a novel conceptual framework encapsulating the PVFs identified and, it is contended that, the manner in which these factors interrelate to produce market value in the NRS.

13.2 Contribution to Knowledge

Market valuation in the NRS is embroiled in mystery. Indeed, traditional valuation methodologies are deemed insufficient in explaining the market values of NRCs. However, rather than abandoning traditional valuation paradigms, this research has approached the research problem from the first principles of finance: accepting the Fisherian[54] notion that the value of any asset is a product of its future cash flows discounted for time and associated risks/uncertainties.

Pointedly, this research argues that the root cause underlying the mystery pervading market valuations in the NRS lies in the immense uncertainty involved in

[53] This latter requirement being a product of the fundamental analysis tradition to which this work is heir.
[54] Fisher (1906, 1930).

estimating the size, timing and probability of future earnings for the sector. Indeed, the nature of the NRS, engaged in exploration and the development of nascent resources, ensures that the sector is saturated in uncertainty. Indeed, due to this ultra-uncertainty, this research has argued that the NRS is properly classified as a subset of venture capital. Thus, valuing NRCs does not lend itself to traditional NPV and DCF analysis because knowledge concerning future earnings is too uncertain (dynamically unstable).

Given that predicting future earnings is highly uncertain in the NRS, the traditional yardsticks and measures of value are incomplete and the market appears to operate through a mysterious 'black box' process. In this manner, valuations in the NRS often appear to depart the realm of traditional ‘Fisherian finance’ for a phantasmagorical realm of speculation, greed, and blind luck. Despite these appearances, this research argues that traditional Fisherian finance can be reconciled with and bring discipline to the unique and often unruly operating environment of the NRS. Specifically, where knowledge concerning future cash flows is highly uncertain and traditional value-relevant factors are unavailable, the market draws upon ‘alternative’ information concerning the prospects for future earnings—even though that information is highly variable and often hales from colourful and/or dubious sources.

Accordingly, this research presents a unique and integrated framework of valuation for the NRS embracing all PVFs germane to the sector. Pointedly, many of the PVFs comprising the framework only provide hints and intimations concerning future cash flows. While in the fullness of time, it is often (perhaps usually) revealed that reliance on these PVFs was unwise, this research argues that alternative informational sources are nonetheless value-relevant and provide access to a richer, more perceptive framework than many traditional valuation methodologies. Indeed, it is contended that such alternative PVFs are a necessity in venture capital valuations. Thus, this research has contributed by extending the scope of traditional Fisherian finance as it is usually implied for the NRS (a specific industry within the broader realm of venture capital) for which it is argued alternative PVFs hold dominion. Consequently, this research has contributed to explaining valuations in the NRS by drawing together a varied palette of PVFs that are of value-relevance to the NRS. Moreover, where previous NRS valuations research has generally focussed on certain PVFs to the exclusion of others, this research has endeavoured to be comprehensive and systematic by encapsulating all relevant PVFs.

Additionally, this research has contributed by seeking to empirically verify many PVFs touted by the literature.

Indeed, the empirical analyses herein yielded a body of results of interest. Particularly intriguingly, the empirical analyses could find no support for the value-relevance of accounting information, despite accounting information's primacy throughout finance and the fundamental analysis tradition. Still, as expected, the importance of global commodity prices to market valuations in the NRS was confirmed. Additionally, this research provided insight into a critical function for all NRCs: the SEO. It was found the NRCs are opportunistic in that they undertake SEOs following sustained market outperformance. This opportunistic behaviour was found to be especially evident for NRCs with lower levels of market liquidity and for companies undertaking large raisings relative to their market capitalisations.

A methodological contribution to the empirical research, is the use of larger samples than any research in the field to date. Kennedy (1996, p.61) affirms the importance of a large sample-size in analysing the NRS, "Exploring for minerals has been likened to a gambling game, but with the explorationists having a lot of control over the odds. Since there was an element of chance, a large sample size was necessary so that underlying characteristics that affected performance could be detected statistically." Specifically, testing the value-relevance of accounting information was based upon a final sample of 2,324 NRCs while the examination of capital raisings was based upon a final sample of 1,526 SEOs. Such large datasets were obtainable through use of the proprietary Intierra (2011) database – the first time use of this dataset had been granted for academic purposes. Further, the samples employed were more representative in that they were not exchange-centric, but drawn from every global exchange with a meaningful NRC contingent. Thus a central contribution of this research is that its empirical analysis is based upon larger and more representative samples than previous work to date.

Moreover, this research contributes through, beyond considering the broad array of PVFs applicable to the NRS, analysing and emphasising the interconnections between these PVFs – interconnections which, in combination, give rise to market value in the sector. For instance, Richardson et al. (2010), in the latest major literature review on the fundamental analysis literature, stressed the need for more holistic analysis examining non-accounting information in complement with accounting information, as well as the need for more contextual analysis to account for the impact of the macro-economic environment. This research helps meet these calls insofar as the NRS is concerned. Therefore, this research contributes to the literature by considering market valuation in the NRS from a comprehensive and systematic orientation, whereby the interconnections and contextual interactions between PVFs are emphasised. In particular, the manner in which PVFs interact in concert to inform market value in the NRS is made explicit through the conceptual framework developed in Chapter 12.

Indeed, through the provision of a novel and integrated conceptual framework, this work maps how PVFs combine, as constellations, to impute market value in the NRS. Thus, this research, to some degree, helps in resolving the general mystery surrounding market valuation in the sector.

13.3 Limitations and Suggestions for Future Research

This research was encumbered by a number of limitations. In particular, while the theoretical analysis of PVFs is comprehensive, additional statistical analysis could have been conducted to test the validity of all purported PVFs. While accounting information, commodity prices and SEOs were all empirically tested under Chapters 3 and 4, similar statistical analyses could have been performed for other PVFs identified throughout Chapters 5 to 11. Indeed, the conceptual framework developed in Chapter 12 is largely a product of the theoretical arm of this work, and if more empirical analysis had been conducted it might have materially influenced the resulting conceptual framework. Accordingly, PVFs which were identified but not empirically verified under this work offer an avenue for future research.

Another limitation afflicting the research flows from the fact that PVFs were identified by surveying the available literature. Consequently, PVFs unknown to the literature could not be included or discovered under this analysis. Such a limitation could be partly overcome through a ‘data mining’ approach - however, such an approach, disconnected from theoretical foundations, would not be without its own shortcomings.

A further limitation concerns this research’s definitional restriction of PVFs to only include quantifiable factors. It has already been noted that the literature considers many non-quantifiable factors to be of value-relevance, in particular, the importance of managements' human capital. This neglect presents a prime opportunity for future research, perhaps through a case study research design.

Also, as noted, this research defines the NRS as those listed companies involved in the resources sector with market capitalisations below US$1.5 billion. Consequently, as the US$ fluctuates through time, so will the US$1.5 billion cut-off value under which this research defines its sample. While this does represent a limitation to the research it is not deemed significant as only a minor portion of the sample will be impacted by such exchange rate fluctuations. This conclusion follows from the asymmetrical distribution of market valuations in the NRS: the distribution follows an exponential function with the number of NRCs declining precipitously with market capitalisation (Iddon, 2010). As previously noted, and owing to this asymmetrical distribution, only approximately 2% of all natural resource companies hold market capitalisations in excess of US$1.5 billion. Consequently, even significant shifts in the US$1.5 billion cut-off figure do not materially alter the sample.

With regards to the empirical analysis, the panel data analysis, investigating the value-relevance of accounting information, was impacted by omitted variable bias (stock exchange and stage-of-development were not included) and measurement error (different fiscal year end-dates were grouped together). Meanwhile, the event study analysis investigating SEOs did not include an important period of interest around the SEO. Specifically, while the event study captured the 90 day period leading up to the announced SEO (including the start-date, i.e. the date on which the SEO was announced to the market), and the 90 days following the SEO (including the end-date, i.e. the date on which the SEO offer was closed), it did not capture the period of time between the start-date and the end-date. Thus, future research might include the period of time between the start-date and end-date. Furthermore, future research might outspread the event window (i.e. extend the period tested prior to the start-date and following the end-date).

A further limitation is that, while both the panel data analysis of accounting data and the event study examining SEOs enjoyed large sample sizes, their time dimension was relatively limited: both circumscribed to the three year period from 2009-11. Future research might be conducted with similarly large sample sizes over longer time periods to ascertain whether the relationships identified persist, or rather, are more dynamically a function of time.

Notwithstanding these limitations, and the ensuing opportunities for future research, this research has contributed, in some measure, to deciphering the mysterious concerning valuation in the NRS. It has been argued that while traditional valuation methodologies are prima facie, inadequate, these methodologies rest on sound foundations. Rather, the divergence between these methodologies and market valuations is likely because the market extends these foundations along more circuitous, imaginative, adventurous (and inevitable error-prone) byways than previously recognised. Moreover, this conclusion probably extends to other arenas of venture capital.

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Appendix A: Intierra Agreement

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Wednesday, 16 May 2012

To whom it may concern

This letter relates to the use of Intierra datasets by Casey Iddon during the period of his PhD candidacy at the University of Ballarat.

Intierra grants permission for Casey to use certain Intierra datasets for the purpose of statistical analysis involved in the research in support of his PhD thesis.

The offer is made subject to the following conditions:

1) Access to the Intierra dataset is restricted to Casey Iddon. The Intierra dataset will remain private and confidential and under no circumstances is any portion of the Intierra dataset to be disclosed to any third party.

2) The PhD thesis referred to here is not scheduled to be published until April 2014.

3) The employment of the Intierra dataset is only to involve historical data. In particular, the data employed is restricted to that which was made public and released by Intierra from 1st January 2005 until 31st December 2011, inclusive.

4) The PhD thesis is only to record the results of the statistical analysis, and necessary statistical descriptions of the Intierra dataset. In particular, at no time and in no form, is any portion of the underlying Intierra dataset to be published or released as part of the PhD thesis (or during any part of the PhD process).

5) Any representation of the Intierra dataset in the final publication will cite and credit Intierra.

Yours sincerely,

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Appendix B: Statistical Analyses Coding

Insert 1 – Transformations and Amelia imputations[55]

```
rm(list=ls())
library(reshape)
library(Amelia)
data <- read.table(file.choose(),header=T,sep=",", fill=TRUE)
data <- reshape(data, direction = "long", varying=4:39)
attach(data)
neg.log <- function(x){ sign(x)*log(abs(x) + 1) }
cube.root <- function(x) {    sign(x) * abs(x)^(1/3) }
cols.neg.log<-c("MC","Debt","DebtToEquity", "ExplorationExpenditure")
data[cols.neg.log] <- neg.log(data[cols.neg.log])
cols.cube.root <- c("NetProfit","NetAssets","WorkingCapital","Profitability")
data [cols.cube.root] <- cube.root(data[cols.cube.root])
a.out.time <- amelia(data, ts = "time", cs = "Code", lags = "MC", leads = "MC", noms = c("Exchange",
"StageOfDevelopment"), polytime =3, p2s=2, empri = 0.01*nrow(data))
write.amelia(obj=a.out.time, file.stem = "outdata")
```

[55] This is the coding for Series 1 and 3. Series 2 is slightly modified to include exploration expenditure. Series 2 involves only the ASX – so the variable of exchange is not included in the analysis.

Insert 2 - Pooling model versus fixed effects model

```
imp.1 <- read.table(file.choose(),header=T,sep=",", fill=TRUE)

imp.2 <- read.table(file.choose(),header=T,sep=",", fill=TRUE)

imp.3 <- read.table(file.choose(),header=T,sep=",", fill=TRUE)

imp.4 <- read.table(file.choose(),header=T,sep=",", fill=TRUE)

imp.5 <- read.table(file.choose(),header=T,sep=",", fill=TRUE)

library(plm)

N <- length(imp.1[,1])   #count the number of observations in imputed file

B <- 1000 # number of times to recompute estimate

store.answer <- rep(0,1000)

for (i in 1:B){

    index <- sample(1:N, (N/5), replace = TRUE)

    data.1 <- imp.1[index,]

    data.2 <- imp.2[index,]

    data.3 <- imp.3[index,]

    data.4 <- imp.4[index,]

    data.5 <- imp.5[index,]

    data <- do.call(rbind, list(data.1, data.2, data.3,data.4,data.5))

    data.plm <- plm.data(data, index=c("Code","time"))

            pooled.test <- plm(MC ~ StageOfDevelopment + Exchange + lag(NetProfit,1) +
lag(Debt,1) + lag(NetAssets,1) + lag(WorkingCapital,1) + lag(DebtToEquity,1) + lag(Profitability,1) +
lag(MacroAbs,1) + lag(ExplorationExpenditure,1), data = data.plm, model = "pooling")

    fixed.test <- plm(MC ~ StageOfDevelopment + Exchange + lag(NetProfit,1) + lag(Debt,1) +
lag(NetAssets,1) + lag(WorkingCapital,1) + lag(DebtToEquity,1) + lag(Profitability,1) +
lag(MacroAbs,1) + lag(ExplorationExpenditure,1), data = data.plm, model = "within")

    a<-pFtest(fixed.test,pooled.test)

    store.answer[i] <- a$p.value

}

median(a$p.value)
```

Insert 3 - Hausman test

```
imp.1 <- read.table(file.choose(),header=T,sep=",", fill=TRUE)
imp.2 <- read.table(file.choose(),header=T,sep=",", fill=TRUE)
imp.3 <- read.table(file.choose(),header=T,sep=",", fill=TRUE)
imp.4 <- read.table(file.choose(),header=T,sep=",", fill=TRUE)
imp.5 <- read.table(file.choose(),header=T,sep=",", fill=TRUE)
library(plm)
N <- length(imp.1[,1])   #count the number of observations in imputed file)
B <- 1000 # number of times to recompute estimate
store.answer <- rep(0,1000)
for (i in 1:B){
   index <- sample(1:N, (N/5), replace = TRUE)
   data.1 <- imp.1[index,]
   data.2 <- imp.2[index,]
   data.3 <- imp.3[index,]
   data.4 <- imp.4[index,]
   data.5 <- imp.5[index,]
   data <- do.call(rbind, list(data.1, data.2, data.3,data.4,data.5))
   data.plm <- plm.data(data, index=c("Code","time"))
   fixed.test <- plm(MC ~ StageOfDevelopment + Exchange + lag(NetProfit,1) + lag(Debt,1) +
lag(NetAssets,1) + lag(WorkingCapital,1) + lag(DebtToEquity,1) + lag(Profitability,1) +
lag(MacroAbs,1) + lag(ExplorationExpenditure,1), data = data.plm, model = "within")
   random.test <- plm(MC ~ StageOfDevelopment + Exchange + lag(NetProfit,1) +
lag(Debt,1) + lag(NetAssets,1) + lag(WorkingCapital,1) + lag(DebtToEquity,1) +
lag(Profitability,1) + lag(MacroAbs,1) + lag(ExplorationExpenditure,1), data = data.plm,
model = "random")
   a<-phtest(random.test,fixed.test)
   store.answer[i] <- a$p.value
}
median(a$p.value)
```

Insert 4 - Breusch-Pagan test

```
imp.1 <- read.table(file.choose(),header=T,sep=",", fill=TRUE)

imp.2 <- read.table(file.choose(),header=T,sep=",", fill=TRUE)

imp.3 <- read.table(file.choose(),header=T,sep=",", fill=TRUE)

imp.4 <- read.table(file.choose(),header=T,sep=",", fill=TRUE)

imp.5 <- read.table(file.choose(),header=T,sep=",", fill=TRUE)

library(plm)

library(lmtest)

N <- length(imp.1[,1])  #count the number of observations in imputed file

B <- 1000 # number of times to recompute estimate

store.answer <- rep(0,1000)

for (i in 1:B){

   index <- sample(1:N, (N/5), replace = TRUE)

   data.1 <- imp.1[index,]

   data.2 <- imp.2[index,]

   data.3 <- imp.3[index,]

   data.4 <- imp.4[index,]

   data.5 <- imp.5[index,]

   data <- do.call(rbind, list(data.1, data.2, data.3,data.4,data.5))

   data.plm <- plm.data(data, index=c("Code","time"))

        a <- bptest(MC ~ StageOfDevelopment + Exchange + lag(NetProfit,1) + lag(Debt,1) +
lag(NetAssets,1) + lag(WorkingCapital,1) + lag(DebtToEquity,1) + lag(Profitability,1) +
lag(MacroAbs,1) + lag(ExplorationExpenditure,1) + factor(Code), data = data.plm, studentize=F)

   store.answer[i] <- a$p.value

}

median(a$p.value)
```

Insert 5 - Dickey-Fuller test

```
imp.1 <- read.table(file.choose(),header=T,sep=",", fill=TRUE)
imp.2 <- read.table(file.choose(),header=T,sep=",", fill=TRUE)
imp.3 <- read.table(file.choose(),header=T,sep=",", fill=TRUE)
imp.4 <- read.table(file.choose(),header=T,sep=",", fill=TRUE)
imp.5 <- read.table(file.choose(),header=T,sep=",", fill=TRUE)
library(plm)
library(tseries)
N <- length(imp.1[,1])   #count the number of observations in imputed file)
B <- 1000 # number of times to recompute estimate
store.answer <- rep(0,1000)
for (i in 1:B){
    index <- sample(1:N, (N/5), replace = TRUE)
    data.1 <- imp.1[index,]
    data.2 <- imp.2[index,]
    data.3 <- imp.3[index,]
    data.4 <- imp.4[index,]
    data.5 <- imp.5[index,]
    data <- do.call(rbind, list(data.1, data.2, data.3,data.4,data.5))
          data.plm <- plm.data(data, index=c("Code","time"))
    a <- adf.test(data.plm$MC, k=2)
          store.answer[i] <- a$p.value
}
median(a$p.value)
```

Insert 6 - Wooldridge's test

```
imp.1 <- read.table(file.choose(),header=T,sep=",", fill=TRUE)

imp.2 <- read.table(file.choose(),header=T,sep=",", fill=TRUE)

imp.3 <- read.table(file.choose(),header=T,sep=",", fill=TRUE)

imp.4 <- read.table(file.choose(),header=T,sep=",", fill=TRUE)

imp.5 <- read.table(file.choose(),header=T,sep=",", fill=TRUE)

library(plm)

library(car)

N <- length(imp.1[,1])   #count the number of observations in imputed file)

B <- 1000 # number of times to recompute estimate

store.answer <- rep(0,1000)

for (i in 1:B){

    index <- sample(1:N, (N/5), replace = TRUE)

    data.1 <- imp.1[index,]

    data.2 <- imp.2[index,]

    data.3 <- imp.3[index,]

    data.4 <- imp.4[index,]

    data.5 <- imp.5[index,]

    data <- do.call(rbind, list(data.1, data.2, data.3,data.4,data.5))

    data.plm <- plm.data(data, index=c("Code","time"))

    a <- pwartest(MC ~ StageOfDevelopment + Exchange + lag(NetProfit,1) + lag(Debt,1) +
lag(NetAssets,1) + lag(WorkingCapital,1) + lag(DebtToEquity,1) + lag(Profitability,1) +
lag(MacroAbs,1) + lag(ExplorationExpenditure,1),data=data.plm)

    store.answer[i] <- a$p.value

}

median(a$p.value)
```

Insert 7 - Aggregating Arellano method sandwich estimators

```
library(lmtest)
imp.1 <- read.table(file.choose(),header=T,sep=",", fill=TRUE)
imp.1.plm <- plm.data(imp.1, index=c("Code","time"))
fixed.test <- plm(MC ~ StageOfDevelopment + Exchange + lag(NetProfit,1) +
lag(Debt,1) + lag(NetAssets,1) + lag(WorkingCapital,1) + lag(DebtToEquity,1) +
lag(Profitability,1) + lag(MacroAbs,1) + lag(ExplorationExpenditure,1), data =
imp.1.plm, model = "within")
results.1 <- coeftest(fixed.test,vcovHC(fixed.test, method = "arellano"))
imp.2 <- read.table(file.choose(),header=T,sep=",", fill=TRUE)
imp.2.plm <- plm.data(imp.2, index=c("Code","time"))
fixed.test <- plm(MC ~ StageOfDevelopment + Exchange + lag(NetProfit,1) +
lag(Debt,1) + lag(NetAssets,1) + lag(WorkingCapital,1) + lag(DebtToEquity,1) +
lag(Profitability,1) + lag(MacroAbs,1) + lag(ExplorationExpenditure,1), data =
imp.2.plm, model = "within")
results.2 <- coeftest(fixed.test,vcovHC(fixed.test, method = "arellano"))
imp.3 <- read.table(file.choose(),header=T,sep=",", fill=TRUE)
imp.3.plm <- plm.data(imp.3, index=c("Code","time"))
fixed.test <- plm(MC ~ StageOfDevelopment +  Exchange + lag(NetProfit,1) +
lag(Debt,1) + lag(NetAssets,1) + lag(WorkingCapital,1) + lag(DebtToEquity,1) +
lag(Profitability,1) + lag(MacroAbs,1) + lag(ExplorationExpenditure,1), data =
imp.3.plm, model = "within")
results.3 <- coeftest(fixed.test,vcovHC(fixed.test, method = "arellano"))
imp.4 <- read.table(file.choose(),header=T,sep=",", fill=TRUE)
imp.4.plm <- plm.data(imp.4, index=c("Code","time"))
fixed.test <- plm(MC ~ StageOfDevelopment + Exchange + lag(NetProfit,1) +
lag(Debt,1) + lag(NetAssets,1) + lag(WorkingCapital,1) + lag(DebtToEquity,1) +
lag(Profitability,1) + lag(MacroAbs,1) + lag(ExplorationExpenditure,1), data =
imp.4.plm, model = "within")
results.4 <- coeftest(fixed.test,vcovHC(fixed.test, method = "arellano"))
imp.5 <- read.table(file.choose(),header=T,sep=",", fill=TRUE)
imp.5.plm <- plm.data(imp.5, index=c("Code","time"))
fixed.test <- plm(MC ~ StageOfDevelopment + Exchange + lag(NetProfit,1) +
lag(Debt,1) + lag(NetAssets,1) + lag(WorkingCapital,1) + lag(DebtToEquity,1) +
lag(Profitability,1) + lag(MacroAbs,1) + lag(ExplorationExpenditure,1), data =
imp.5.plm, model = "within")
results.5 <- coeftest(fixed.test,vcovHC(fixed.test, method = "arellano"))
combine_imputations <- function(results.1, results.2, results.3, results.4,
results.5,pos_coeff, pos_se) {
        av.coeff<- (results.1[pos_coeff] + results.2[pos_coeff] + results.3[pos_coeff] +
results.4[pos_coeff] + results.5[pos_coeff])/5
        within.imp.var <- (results.1[pos_se] + results.2[pos_se] + results.3[pos_se] +
results.4[pos_se] + results.5[pos_se])/5
        between.imp.var <- (1/(5-1))*((results.1[pos_coeff]-av.coeff)^2 +
(results.2[pos_coeff]-av.coeff)^2 + (results.3[pos_coeff]-av.coeff)^2 +
(results.4[pos_coeff]-av.coeff)^2 + (results.5[pos_coeff]-av.coeff)^2)
        standard_error <- sqrt(within.imp.var + ((1+(1/5))*between.imp.var))
```

Insert 8 - Multiple regression analysis

```
rm(list=ls())

library(reshape)

data <- read.table(file.choose(),header=T,sep=",", fill=TRUE)

attach(data)

names(data)

cols.log<-c("Size","SizeToMC","Speed", "MC", "SharePrice","StdDev", "Liquidity")

data[cols.log] <- log(data[cols.log])

mod_before<-lm(CAR_Before~
Macro+Exchange+Size+SizeToMC+Speed+MC+SharePrice+StdDev+Liquidity+Activity)

mod_after<-lm(CAR_After~
Macro+Exchange+Size+SizeToMC+Speed+MC+SharePrice+StdDev+Liquidity+Activity)

summary(mod_before)

summary(mod_after)
```