SEC REPORTING RESTRICTIONS IN THE MINING INDUSTRY: AN EXAMINATION OF THE MODELLING AND VALUE-RELEVANCE OF GOLD RESOURCE ESTIMATES

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AUTHORSHIP/ORIGINALITY STATEMENT

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

Signed …………………………………………………………………………….

Date……………………………………………………………………………..

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List of Acronyms

AASB	Australian Accounting Standards Board
AMEX	American Stock Exchange (now NYSE MKT LLC)
ASX	Australian Stock Exchange[1]
BVE	Book Value of Equity
CIM	Canadian Institute of Mining, Metallurgy and Petroleum
COG	Cut-Off Grade
CSA	Canadian Securities Administrators
DSE	Development-Stage Enterprise
EBITDA	Earnings Before Interest, Tax, Depreciation and Amortisation
EDGAR	Electronic Data Gathering, Analysis and Retrieval
GAAP	Generally Accepted Accounting Principles
HVP	Hotelling Valuation Principle
IAS	International Accounting Standard
IFRS	International Financial Reporting Standard
IPO	Initial Public Offering
JORC	Joint Ore Reserves Committee
LHS	Left-Hand Side
MVE	Market Value of Equity
NI	National Instrument
NPS	National Policy Statement
NYSE	New York Stock Exchange
OLS	Ordinary Least Squares
OTCBB	Over-the-Counter Bulletin Board
Ph.D.	Doctorate of Philosophy
PRMS	Petroleum Resources Management System
RHS	Right-Hand Side
ROM	Run-Of-Mine
SEC	Securities and Exchange Commission
SEDAR	System for Electronic Data Analysis and Retrieval
SFAC	Statement of Financial Accounting Concepts
SFAS	Statement of Financial Accounting Standards
SIX	Swiss Exchange
SME	Society for Mining, Metallurgy and Exploration
SPPR	Share Price and Price Relative
TSX(V)	Toronto Stock Exchange (Venture Exchange)
UK	United Kingdom of Great Britain and Northern Ireland
UN	United Nations
US(A)	United States (of America)
USD	United States (of America) Dollars

[1] ASX can also refer to the Australian Securities Exchange, which comprises the Australian Stock Exchange and the Sydney Futures Exchange.

Abstract

I investigate the information content of gold mining firms' estimates of contingent and inferred resources. Contingent resources are distinguished from reserves because contingent resources are not economically viable under current conditions. Inferred resources are distinguished from the others in that they are too preliminary for a reliable assessment of their economic viability. Disclosing these two categories is required in Australia and Canada, but prohibited in the USA by SEC Industry Guide 7. I examine the informativeness of resource estimates in two ways: the association with ex post changes in reserve estimates, and the association with market prices. Following the resource reporting framework, I provide evidence that contingent resources are informative when considered together with gold price movements, and inferred resources are informative when considered together with exploration expenditure and the commercial viability of developed resources. I also provide evidence that the decomposition of estimates of mineralised material into contingent and inferred resources is only weakly associated with corporate disclosure allowed by the SEC. My results inform the regulatory debate over the harmonisation of resource reporting codes by highlighting the utility of the prohibited categories. My result also contributes to the literature that has hitherto focused on reserve estimates. It would appear that, while the SEC prohibition is motivated by concerns of investors being 'misled,' by distorting the disclosure of useful information, the SEC is increasing investor confusion.

1.0 <u>Introduction</u>

The valuation of resource projects is primarily based on estimates of the *in situ* mineral resources (Hotelling, 1931; Brennan and Schwartz, 1985). The purpose of disclosing resource estimates is to facilitate the prediction of future production, which is the key determinant of operating cash flow. Extraction firms disclose resource estimates based on a resource code. These codes categorise resource estimates on the basis of geological certainty and commercial viability. Estimates of ore reserves must be based on reasonable or high geological certainty, and current commercial viability. The Joint Ore Reserves Committee (JORC) Code in Australasia and the Canadian Institute of Mining, Metallurgy and Petroleum (CIM) Definition Standards utilise the same categories of mineral resource estimates.[2] In the USA, however, Securities and Exchange Commission (SEC) Industry Guide 7 limits resource reporting to currently commercially viable reserves, and prohibits the disclosure of estimates of currently commercially unviable contingent resources and currently commercially unverifiable inferred resources. I investigate the information content of the resource estimate categories prohibited by SEC Industry Guide 7 and its impact upon the information environment of gold mining firms.

The SEC is motivated by the concern that unsophisticated investors might be 'misled' by these low reliability estimates. The JORC Code and CIM Definition Standards require the disclosure of estimates of contingent and inferred resources, consistent with these estimates being price-sensitive as real options (Brennan and Schwartz, 1985). My objective is to test the information content in disclosing estimates of contingent and inferred resources. Specifically, I investigate (i) whether the prohibited categories are useful in predicting future revisions of ore reserve estimates, and (ii) whether the prohibited categories are price-sensitive.

My motivation is twofold. First, the SEC prohibits the disclosure of estimates of uncommercial and preliminary resources, contingent and inferred respectively. The

[2] The names of the categories are identical, but the definitions do vary slightly, as I discuss in Section 2.3.2 'the JORC Code, SME Guide, and CIM Definition Standards.'

disclosure literature examines many types of supplementary disclosure and disclosure policy choice, but the prohibition of disclosure is rare.[3] The SEC prohibition is contrary to the push towards international harmonisation by major reporting codes such as the JORC Code and CIM Definition Standards, as well as ignoring the recommendations of the USA's own professional mining body, the Society for Mining, Metallurgy and Exploration (SME; SME, 2012). The SEC prohibition is also consistent with a broader tension between the SEC requiring conservative reporting, in order to protect unsophisticated investors, and other regulatory bodies encouraging neutral reporting, in order to assist investors more broadly.

Estimates of ore reserves capture the portion of total resources that are commercially viable, at the time of estimation. Contingent resources are commercially unviable, but can still be informative given possible future improvements in the commodity price, reduction in extraction costs, or increases in the estimated resource grade. Inferred resources are too preliminary to assess commercial viability, because they are estimated from a small data set, but can still be informative as a timely indication of future estimates. The continuous disclosure regimes of Australia and Canada require the disclosure of estimates of contingent and inferred resources, and the JORC Code and CIM Definition Standards require the clear distinction between the two categories. It is worth noting that the SEC exempts firms cross-listed on foreign exchanges, such as in Australia and Canada, from the prohibition against disclosing estimates of contingent and inferred resources.

Second, mineral resource estimates are important for the analysis of mining companies. The mining of finite resource deposits is closely linked to their geological and commercial *in situ* properties. Prior research on reserve recognition accounting focuses on the comparable framework for reporting oil and gas reserves. While the SEC prohibition has been removed for oil and gas activities,[4] the prohibition remains for

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[3] *e.g.* the SEC 'quiet period' for Initial Public Offerings.
[4] SEC Release No 33-8995.

mining activities. This unexplained double standard highlights a need for more research into mining resource estimates.

Prior oil and gas research examines the reliability (precision and bias) of estimates of oil and gas reserves through one-year-ahead revisions, without considering a longer revision horizon.[5] Adelman (1990) emphasises that over the long-run, reserve revisions tend to be positive and quite large. Watkins (1992) reports that in Alberta, the average proportion of total *ex post* production to initial *ex ante* reserve estimates was roughly nine-fold for oil and five-fold for gas, with annual growth in reserves of 10%. Examining longer revision horizons is necessary for evaluating (a) the marginal resources within contingent resources, and, (b) preliminary estimates in an early stage of evaluation (inferred resources). While some oil and gas research has examined the determinants of reserve revisions,[6] this research has not considered a longer horizon. Longer horizons are necessary for the determinants of resource revision to accumulate to the critical amount necessary to play a role. In addition, although a few studies have examined price-sensitivity,[7] the oil and gas literature has not compared the predictive ability of reporting resource estimates under different levels of confidence.

Based on a sample of up to 657 gold mining firm-years with resource estimates disclosed between 1995 and 2008, I utilise an Ordinary Least Squares (OLS) regression approach to assess the association between *ex ante* estimates of resources (categorised under the JORC, CIM and SEC codes) and *ex post* future revisions of reserve estimates. I also assess the association between these estimates and firms' market prices. Following the structure of the resource reporting code framework, I examine the impact of gold price movements on estimates of contingent resources, and exploration expenditure on estimates of inferred resources. Lastly, I investigate the extent to which the estimate categories prohibited by the SEC can be predicted from other information allowed by the SEC.

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[5] King (1982), Walther and Evans (1982), Kahn *et al.* (1983), Campbell (1984), Campbell (1988), Alciatore (1990), Spear and Lee (1999).
[6] Alciatore (1993), Spear (1994), and Boone (2002).
[7] Berry and Wright (1997), Berry *et al.* (1997), Donker *et al.* (2006).

My first hypothesis states that estimates of contingent resources and inferred resources are useful in predicting future reserves and are also price-sensitive. While I report limited evidence of their predictive ability, I find no supporting evidence for their price-sensitivity. A naïve prediction (*i.e.,* without explanatory variables) suggests that, on average within my sample, 12% of contingent resources are reclassifed into reserves, but the variance is relatively high beyond a horizon of two years. A similar naïve prediction suggests that after three years 27% of inferred resources are reclassifed into reserves, but the variance is relatively high after six years.

Moving on to examining the causes of reclassification, my second hypothesis states that gold price movements are related to the informativeness of estimates of contingent resources. I find evidence that sustained *ex post* increases in the gold price are associated with *ex ante* estimates of commercially unviable contingent resources being *ex post* reclassified as commercially viable ore reserves. I report a negative association between the price-sensitivity of contingent resources and lagged increases in the gold price, which may be a reflection of the difficulty in utilising lagged gold price movements as an *ex ante* proxy for future gold price movements.

My third hypothesis states that exploration is related to the informativeness of estimates of inferred resources. I find evidence that sustained *ex post* exploration expenditure is associated with *ex ante* preliminary estimates of inferred resources being *ex post* reclassified as developed resources (ore reserves and contingent resources). However, I find no supporting evidence for current exploration expenditure being associated with the price-sensitivity of inferred resources. My fourth hypothesis states that the relative commercial viability of existing developed resources is also related to the informativeness of estimates of inferred resources. I find evidence that the relative commercial viability of existing developed resources combined with sustained *ex post* exploration expenditure is associated with estimates of inferred resources being *ex post* reclassified as developed resources. I also find evidence that the relative commercial viability of existing developed resources combined with current exploration expenditure is associated with the price-sensitivity of inferred resources.

The restrictions of SEC Industry Guide 7 may not be onerous if investors can obtain similar information from other sources. In additional tests, I examine the ability to predict the decomposition of estimates of mineralised material into contingent resources and inferred resources, using only publically available information that is not prohibited by SEC Industry Guide 7. For producers, firms with active production, I find very weak evidence in support of using other information to decompose mineralised material. For developers, firms with reserves but no active production, while more variables help to predict the decomposition, the explanatory power is not economically significant.

Overall, my results suggest that, while estimates of contingent resources and inferred resources do not appear to be very informative by themselves, when combined with the drivers of their respective reclassification into reserves, the resource categories prohibited by SEC Industry Guide 7 can be informative. It may take several years for mineralised material to be significantly reclassified as ore reserves, and not all material is reclassified, but it does happen.

My findings contribute to the academic literature by demonstrating that estimates of contingent and inferred resources are useful in predicting future revisions to reserve estimates. Prior literature examining estimates of oil and gas resources suggests that only estimates of reserves are useful.[8] Consistent with the reporting framework, I demonstrate that the impact of contingent resource estimates is linked to movements in the gold price, and the impact of inferred resource estimates is linked to exploration expenditure and the relative commercial viability of existing developed resources.

My findings also contribute to the regulatory debate between the SEC and the mining industry. My results are consistent with the widely held belief in the international mining community that the categories prohibited by the SEC are informative (Vaughn

[8] *e.g.* Clinch and Magliolo (1982), Berry and Wright (1997), Berry and Wright (2001).

and Felderhof, 2002; SME, 2012). By prohibiting these categories, the SEC is prohibiting the disclosure of relevant information. It would appear that, while the SEC prohibition is motivated by concerns of investors being 'misled,' by distorting the disclosure of useful information, the SEC is increasing investor confusion.

Although the SEC does presently permit the disclosure of contingent resources as 'mineralized material,' the distinction between mineral resources confidently assessed as uncommercial (contingent) and mineral resources not as yet assessed commercially (inferred) is highly informative when assessing the growth potential of a deposit, because the reclassification of these two types of mineralised material have different drivers.

While it is clearly beyond the scope of my thesis to criticise the ultimate policy decisions of either side of this regulatory debate, my thesis does aim to inform the debate by providing some empirical evidence of the contrast between the two policies, as far as sophisticated decision makers are concerned, by demonstrating the utility of distinguishing between estimates of contingent and inferred resources. Empirically examining the existence, frequency, magnitude and cost of misleading 'unsophisticated' decision makers is beyond the scope of my thesis, and thus so also is any overall conclusion for or against either side of the debate.[9]

My thesis indirectly contributes towards our understanding of the trade-off between the principles of relevance and reliability imbedded within the financial reporting framework. The resource reporting framework offers a different approach to this trade-off by categorising estimates based on their underlying reliability.[10] This way, mining firms can disclose high relevance-low reliability estimates in a timely fashion without obscuring the distinction with high reliability estimates through information-destroying aggregation. By examining the (conditional) predictive ability of these low

[9] The argument that an action by a corporation can adversely affect 'unsophisticated' investors is vulnerable to the 'no true Scotsman' fallacy of logic. The 'no true Scotsman' fallacy of logic occurs when one modifies the definition of the subject of an argument in order to guarantee the conclusion of that argument (Flew, 1975). If unsophisticated investors are defined as investors that can be easily mislead by corporate disclosure, then the SEC argument is circular.

[10] SFAS 157 "Fair Value Measurements" also includes a framework based on the categorisation of fair value measurements by the prescriptive reliability of the inputs.

reliability estimates, my thesis provides evidence of the utility of a categorisation framework.

The remainder of my thesis is organised as follows. The second Section provides an overview of the institutional background, namely resource reporting. The third Section develops the four hypotheses that will be tested (with two sub-hypotheses each). The fourth Section outlines the methods by which the hypotheses will be tested. The fifth Section discusses the results from the tests. The sixth Section provides a concluding discussion of the results and my overall thesis.

2.0 Institutional Background: resource reporting

2.1 The mining cycle

The life cycle of a mining project can be separated into three stages: (i) the exploration and development stage, (ii) the production stage, and (iii) the rehabilitation stage. The intuition behind this trichotomy is simple; the middle stage is the only stage when the project earns production revenues, while the first and last stages incur only costs.[11]

2.1.1 The exploration and development stage of the mining cycle

2.1.1.1 The exploration sub-stage of the mining cycle

The exploration sub-stage has three phases, prospecting, evaluation and definition. The prospecting phase typically involves: (i) selecting a tenement of land or seabed that may contain resources, based on publically available information, aero-magnetic tests, aero-radiometry, *etc*., (ii) acquiring a license from the relevant authority to conduct prospecting activities on that tenement, (iii) undertaking some inexpensive

[11] An alternate trichotomy, based on the length of each stage, could separate exploration and development into separate stages, and unite production and rehabilitation into a single stage.

preliminary geological tests, such as surface or stream sampling, trenching, *etc*., (iv) drilling a pattern of narrow but deep holes to obtain drill cores (the dirt from within the hole) for analysis of mineral content ('core drilling'), and (v) further drilling, through a variety of means, between these preliminary holes ('in-fill drilling').

Exploration licenses restrict the exploration procedures that can be employed, impose environmental impact and safety conditions, outline a process for the eventual rehabilitation of the land, and specify the minimum conditions required to retain the license.

The evaluation phase involves analysing the drilling results from prospecting, and applying a suitable geotechnical model to estimate the distribution of the 'mineral resources' and waste material within the orebody. Estimating a three-dimensional layout of the resources based on isolated drill locations requires making educated assumptions about the continuity of the resources between these data points. To improve the geological confidence of the model, further drilling increases the number and proximity of data points upon which the model is derived.

The definition phase involves analysing the three-dimensional layout of the resources from evaluation to estimate the amount of the resources that are commercially viable, known as 'ore reserves.' Defining the reserves requires forecasts of production costs and revenues. At a given point in time, the resource grade is the primary deposit-level factor that influences the delineation between commercially viable and unviable resources within an orebody. The resource grade measures the proportion of marketable commodity to ore. *Ceteris paribus*, the higher the grade, the higher the commercial viability. A secondary factor is the distribution of the resources. *Ceteris paribus*, economies of scale translate to concentrated resources having higher commercial viability than sparsely distributed resources. As time passes, the forecasts of production costs and revenues will fluctuate and thereby affect the delineation between commercially viable and unviable resources. Once again, further drilling yields more data and changes the resource and reserve estimates.

As is inherent in all estimation activities, assumptions are necessary for extrapolating continuity from a geological data set. Important assumptions underlying resource estimation include cut-off grade (COG), top-cut grade, and in the case of reserves, dilution factors. COGs refer to the truncation of data, whereby data below a given COG level are substituted with zero for the purpose of the resource estimate. Although COG assumptions are to a certain extent arbitrarily identified, COGs are intended to correspond to assumptions of commercial viability whereby ore below a given COG is assumed to be without commercial potential and thus not relevant to decision makers. As commercial viability can change over time, it is foreseeable that assumptions of commercial viability, and therefore COG assumptions, may change accordingly.

Top-cut grade refers to the winsorisation of data, whereby data above a given top-cut grade are capped at the top-cut grade for the purpose of the resource estimate. Top-cut grade assumptions are to a large extent arbitrarily identified, as their function is econometric, not commercial as is the case with COGs. The persuasiveness of a given top-cut grade assumption is linked to the variance in the data, as well as the nature of the identified geological phenomenon. For example, the infamous Bre-X fraud was based on the fraudulent suggestion of an entirely new geological phenomenon with abnormally high resource grades, and it was claimed that an abnormally high top-cut grade was reasonable (Brown and Burdekin, 2000).

Dilution factors, expressed as a percentage, refer to the reduction in grade corresponding to the conversion of resources into reserves. Dilution factors are intended to capture the amount of adjacent waste or low-grade material that is extracted with the reserves, as opposed to waste material that is extracted prior to mining the reserves. The persuasiveness of a given dilution factor is a function of the estimated continuity of the resource and the delineation between the commercially viable and unviable parts of that resource.

2.1.1.2 The development sub-stage of the mining cycle

Once the project manager has a good idea of the commercial viability of the reserves within the orebody, development can begin. Development involves (i) acquiring a license from the relevant authority to engage in the extraction of resources, (ii) acquiring the necessary funding for development, (iii) constructing the infrastructure required to bring the project into production, and (iv) either removing the waste material above or adjacent to the ore reserves ('stripping'), or digging the necessary underground tunnels.

In addition to the license required to conduct exploration, production requires its own license. The Three Mines Uranium Policy in Australia is an example of a setting where licenses for uranium exploration are commonly granted but licenses for uranium production have been historically rare. Production licenses restrict the choice of production procedures, impose environmental impact and safety conditions, outline a process for the eventual rehabilitation of the area, impose production royalties and other taxes, *etc*.

As with exploration, development does not earn production revenues, and thus must be financed through other means. Development requires considerably more funds than exploration, and often requires raising significant additional debt or equity capital to complete the necessary construction. The typical funding process involves compiling a final feasibility report,[12] which outlines the quantity of the reserves and resources, as well as forecasts of project revenues, capital costs and operating costs. This final feasibility report is disclosed to potential capital providers in order to raise the capital required for development.

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[12] To facilitate the timely flow of information/estimates, back-of-envelope feasibility reports, pre-feasibility reports and preliminary feasibility reports are sometimes disclosed prior to the final feasibility report. Also note that the application for a production license requires a description of the intended operating processes, which usually are based on an internal feasibility report.

The overall exploration and development stage can last several years, all without earning any production revenue. When the long time span is combined with the considerable capital funding required, as well as the low probability of success, the exploration and development stage involves a level of risk that is significantly larger than established industrial projects.[13] Once the exploration and development stage has ended, and should the feasibility assumptions be satisfied, the project can begin production and thereby generate a payoff.

2.1.2 The production stage of the mining cycle

The production stage involves two activities; extraction, also called mining, and processing, also called milling or refining. Extraction involves digging up the ore from under the ground. In the modern gold industry, extraction can take two forms; open pit and underground.[14] As the names suggest, open pit extraction involves digging up all the ore from a large open pit, including waste material from around the ore, while underground extraction involves removing ore from underground declines. Open pit extraction is far less costly than underground extraction, and therefore underground extraction requires a higher grade to be commercially feasible. Generally, open pit mining is preferable when the ore is close to the surface, *i.e.*, a low amount of waste material is required to be extracted to get to the ore, while underground mining is preferable when the ore is deep below the surface, *i.e.*, the cost of extracting the waste material through open pit mining would be greater than the cost savings. Some projects have both an open pit component and an underground component.

[13] Whether the risk involved with developmental extraction projects is more or less than the risk involved with developmental industrial projects is an open question. Ferguson *et al*. (2011a) emphasise the difference in estimating bankruptcy risk for industrial and mining firms. On the one hand, the standardisation and quantification of reserve and resource estimates reduces the information asymmetry between insiders and outsiders of extraction projects. On the other hand, industrial projects may have a higher probability of commercial success or a shorter research and development stage.

[14] Historically, the extraction of gold from alluvial deposits, close to the surface, typically near running water, was another form. Strip mining is a type of open pit mining that follows a long strip rather than a deep pit.

Processing involves removing and refining marketable commodities from within the extracted ore. In the modern gold industry, removing the commodity can take two non-mutually exclusive forms; crushing and leaching.[15] As the name suggests, crushing involves an industrial machine crushing and sifting the ore to facilitate the separation of the heavy dense metal from the light brittle ore. Crushing often involves a sequence of crushing machines, designed to reduce the ore into progressively finer material, and ends with a form of leaching. The per unit cost of crushing can vary with the toughness of the rock. Leaching involves applying acidic chemical reagents to the ore which react with the metal to form soluble salts which can be collected and converted back into the pure metal. Leaching can be applied to the crushed material or to the ore directly. Crushing is more expensive than leaching, but typically has a higher recovery rate. Therefore, crushing generally requires a higher grade than leaching to be commercially feasible.

Ore that has been extracted but not yet processed is referred to as 'run-of-mine (ROM) stockpile.' ROM stockpile can include marginal resources that were extracted along with the reserves, but are not commercially feasible for processing under current market conditions. ROM stockpile can also include waste from crushing that has been retained for leaching. Any marketable commodities extracted and processed with the gold are referred to as 'by-products' or 'production credits,' and can include metals such as silver, copper, lead, *etc*.

Once the commodities have been refined into a marketable state, the commodities are mostly sold on the international market. Any marketable commodities that have been refined but not yet sold become inventory. Generally, to ensure that their operations are profitable, mining firms will either forward sell their commodities, or manage a hedge book to the same effect. The commodity price assumed in the feasibility report is generally conservative relative to current prices to allow for some fluctuation in the commodity price, while the average realised sale price may be higher or lower than the

[15] Historically, alluvial mining utilised sifting to separate the gold from the ore. Sifting is still a part of the crushing process today, albeit on an industrial scale. Smelting involves a combination of crushing, leaching and melting the ore to get the metal.

average market price, depending upon market fluctuations relative to the forward/hedge position.

2.1.3 The rehabilitation stage of the mining cycle

Once the reserves have been fully extracted, processed and sold, the project owner is required under the production license to rehabilitate the land into its original natural state. Rehabilitation is also required by exploration licenses for land that is not to be developed. Rehabilitation includes filling in the pits or tunnels with suitable waste material. Rehabilitation may also include restoring the surface vegetation. Restoring the natural vegetation in a forested area is more costly than restoring jungle or grassland, while restoring arid desert is the cheapest.

Rehabilitation is a cost; it does not earn any contemporaneous revenue. To prevent mining firms from simply declaring bankruptcy after the reserves have been exhausted, in order to avoid paying for the rehabilitation, local authorities require funds to be set aside into trust accounts. In the case of the USA, the federal government also requires mining firms to contribute into a 'super fund' for the financing of the rehabilitation of projects where the relevant mining firm has declared bankruptcy, such as extreme environmental situations when the restoration becomes far too costly for the firm. Commonly, mining firms postpone rehabilitation by holding the resources as real options, subject to the requirements of the license. For example, after many years of production, the Holt gold mine in Ontario was closed by Barrick Gold Corporation in 2004, sold to Newmont Mining Corporation in 2005, sold again in 2006 to St Andrews Goldfields Ltd. and recommenced production in late 2010.

2.2 Financial reporting[16]

Within the Generally Accepted Accounting Principles (GAAP) conceptual framework,[17] which includes the historical cost, matching and conservatism principles, mining firm's financial reports record their financial performance and financial position. While financial information can provide some insights into the underlying financial situation of mining firms, the financial reporting is still bound by the limitations of the GAAP framework.

2.2.1 Exploration and development costs

The acquisition costs of mining properties are subject to the usual accounting treatment for property; the historical cost is capitalised (historic cost principle), subject to an impairment test (conservatism principle), and depreciated in later periods (matching principle).[18] However, subsequent exploration and evaluation costs are not necessarily treated in the same manner. This difference is interesting given that, similar to the accounting treatment of intangible assets, purchased (externally-generated) exploration costs are permitted to be capitalised, while internally-generated costs may not be so. As mining development-stage enterprises (DSEs) can take years to sell any output, and not all business and corporate costs can be capitalised, it is typical for mining DSEs to report substantial accumulated losses in the equity section of their balance sheets.

Within a given jurisdiction, the financial reporting of exploration and evaluation (including definition) costs is often similar in function to the corresponding financial reporting of research and development costs.[19] The relevant international accounting standard is the International Financial Reporting Standard (IFRS) 6 "Exploration for and

[16] A detailed description of the nuances of the financial reporting issues relating to mining firms is beyond the scope of my thesis. I discuss only the basic requirements in order to understand the interaction between financial reporting and resource reporting.

[17] SFAC 2 "Qualitative Characteristics of Accounting Information;" IASB project "Conceptual Framework."

[18] IAS 16 "Property, Plant and Equipment," SFAS 6 "Accounting for Property, Plant and Equipment."

[19] IAS 38 "Intangible Assets," SFAS 2 "Accounting for Research and Development Costs."

Evaluation of Mineral Resources."[20] IFRS 6 essentially allows mining firms to continue their previous accounting policies for exploration and evaluation costs while the international debate on harmonisation continues. In North America, extraction firms (mining, oil and gas) apply either the 'successful efforts' method[21] or the 'full cost' method.[22] In Australia, extraction firms apply the 'area of interest' method.[23] Another method available in all jurisdictions, though seldom used, is the immediate write-off method, whereby no exploration and evaluation costs are deferred because these costs are expensed as incurred.

Under the successful efforts method, on an individual project basis, exploration and evaluation costs must be expensed as incurred, unless the project has been demonstrated as successful. Once a project is successful, any subsequent historical costs can be capitalised, subject to an impairment test. This is the more conservative treatment of the deferred exploration and evaluation asset, a 'balance sheet approach,'[24] whereby the recognised asset includes successful projects only. The designation of a project as successful is linked to the identification of reserves or resources, which I will discuss in Section 2.3 'resource reporting codes.' Any capitalised exploration and evaluation costs are either transferred to the capitalised mining property cost, if and when production begins, or written-off if production is not expected.

[20] International accounting standards were adopted in Australia in 2005 and Canada in 2011, but not the USA as of June 2013.

[21] SFAS 19 "Financial Reporting by Oil and Gas Producing Companies." While this standard technically only refers to oil and gas operations, in the absence of a specific standard for mining operations (and the specific exclusion of oil, gas and mining operations from SFAS 2 and SFAS 7 "Accounting and Reporting by Developments Stage Enterprises."), SFAS 19 is considered persuasive by the USA mining industry.

[22] SEC *Reg S-X* §210.4-10 "Financial accounting and reporting for oil and gas producing activities pursuant to the federal securities laws and the *Energy Policy and Conservation Act* 1975." While this standard technically only refers to oil and gas operations, in the absence of a specific standard for mining operations (and the specific exclusion of oil, gas and mining operations from SFAS 2 and SFAS 7), *Reg S-X* §210.4-10 is considered persuasive by the USA mining industry.

[23] AASB 6 "Exploration for and Evaluation of Mineral Resource."

[24] The 'balance sheet approach' is based on the principle that "the proper valuation of assets and liabilities [is] the primary goal of financial reporting, with … the determination of income statement amounts and especially earnings … governed by balance sheet considerations." Dichev (2008) p 454. Within the historical cost framework, the balance sheet approach typically prioritises the conservatism principle over the matching principle.

Under the full cost method, all exploration and evaluation costs can be capitalised, on a historical cost basis. The full cost method is similar to a form of application of the successful efforts method whereby the entire globe is designated as 'one project,' although costs are typically grouped by country. The intuition behind the full cost method is that, as typically most exploration projects are unsuccessful, grouping the wins with the losses matches benefits with costs, and thereby provides a more accurate representation of exploration performance, an 'income statement approach.'[25] Within a country group, all exploration and evaluation costs are capitalised, and then amortised based on the estimated production of the producing properties.

The area of interest method represents a middle position between the two North American methods. Under the area of interest method, exploration and evaluation costs are capitalised, on a historical cost basis, subject to an impairment test, where both (a) a future benefit is expected, but not necessarily demonstrated through a reserve estimate, and (b) the exploration and evaluation activities have either been successful, by identifying reserves or resources, or are ongoing. The size of an 'area of interest' is essentially at the discretion of management, and could be as narrow as the successful efforts method or as broad as the full cost method. On an area of interest basis, capitalised exploration and evaluation costs are either transferred to the capitalised mining property cost, if and when production begins, or written-off if production is not expected.

Bryant (2003) and Cortese *et al*. (2009) discuss the different effects of the successful efforts method and the full cost method. For a fixed number of projects, the successful efforts method initially gives a lower profit, due to the early expensing of unsuccessful endeavours, while the full cost method initially gives a higher profit. Later, as the project matures, the situation reverses and the successful efforts method gives a higher profit, due to a smaller asset base, while the full cost method gives a lower profit.

[25] The 'income statement approach' is based on the principle that "the determination of revenues, expenses and especially earnings [is] the primary goal of financial reporting [, with] … emphasis … on the proper determination of the timing and magnitude of the revenue and expense amounts, whereas balance sheet accounts and amounts are secondary and derivative." Dichev (2008) p 455. Within the historical cost framework, the income statement approach typically prioritises the matching principle over the conservatism principle.

For a variable number of projects, the difference depends upon whether the project portfolio is growing or declining. If the portfolio is growing (declining), the successful efforts method will give a lower (higher) profit than the full cost method, because the effect of expensing unsuccessful endeavours is greater (smaller) than the effect of a smaller asset base. If the size of the aggregate portfolio of projects, in units of expected production, is static, all methods, including immediate write-off, will give the same profit, because the effects of the old projects are cancelled out by the effects of the new projects. The area of interest method is always in between the successful efforts method and full cost method, depending upon how the area of interest is defined.

Development costs are subject to the usual accounting treatment for plant; the historical cost is capitalised, subject to an impairment test, and depreciated in later periods.[26] All three jurisdictions allow the capitalisation of mine development costs, including stripping costs. Although some jurisdictions require the identification of reserves as a precondition for capitalising development costs, it is highly unlikely that without such a requirement, on a project basis, mining firms would incur development costs without first identifying reserves. Purchases of mining raw materials inventory (such as various chemicals), which are also required prior to commencing production, are capitalised as per their usual accounting treatment.[27]

2.2.2 Production profits, including anticipated rehabilitation costs

When the mining firm commences production, it begins to sell the mining output, with the matching principle encouraging the matching of costs with revenues. In addition to total net sales revenue reported under GAAP, mining firms typically also voluntarily report the average ‘realised’ price per commodity unit, and the corresponding units sold. Average realised price per unit can include prices from forward sales contracts, net prices from hedging arrangements, or straightforward cash sales.[28] Hedge books are recognised

[26] IAS 16 “Property, Plant and Equipment,” SFAS 6 “Accounting for Property, Plant and Equipment.”
[27] IAS 2 “Inventories,” Accounting Research Bulletin No. 43, Chapter 4 “Inventory Pricing.”
[28] It is also common for mining firms to report the average market price during the same period, in order to assist comparison with the realised price.

on the balance sheet at their fair value.[29] The corresponding units sold are typically based on the date of shipping.

The cost of goods sold expense that is matched to sales revenue consists of costs of raw material inventory consumed during the period, amortised mining property costs and any additional allocated overhead costs. Mining property costs are usually amortised on a units of production basis, especially for mining DSEs, but can also be amortised on a straight-line basis. Either way, the amortisation of mining property costs requires an estimate of the useful life of the mining property, expressed in units of production or years. The useful life is estimated from the quantity of estimated reserves, either directly, or via the estimated mine life, which is the reserves divided by annual production.

In addition to deferred exploration and development costs, mining property costs include estimated future rehabilitation costs which are brought forward to the production stage, to be matched with revenues.[30] Rehabilitation liabilities are recognised when the legal obligation to rehabilitate land arises. As the process of exploration can involve disturbing the land, rehabilitation liabilities can be recognised even during the exploration stage. The amount of the recognised liability is the present value of the estimated future rehabilitation costs. A corresponding amount of present value of the brought forward rehabilitation cost is added to the mining property costs. In addition, cash is required to be transferred into a trust account to fund the rehabilitation, based on a mandated minimum amount. As time progresses, the interest from the trust account is recognised as revenue, although the cash from the interest remains in the trust account and the accretions of the rehabilitation asset and the liability are recognised.

During production, the estimated future rehabilitation costs are amortised along with the other mining property costs as specified above. When the reserves are exhausted and production ceases, rehabilitation can commence. In the case of areas used in

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[29] IAS 39 "Financial Instruments: Recognition and Measurement," SFAS 133 "Accounting for Derivative Instruments and Hedging Activities."
[30] IAS 37 "Provisions, Contingent Liabilities and Contingent Assets." SFAS 143 "Accounting for Asset Retirement Obligations."

exploration but not developed into production, the production stage is skipped. The rehabilitation activities are funded by the accumulated cash in the trust account. As with the realisation of other long-term assets, any gain or loss on completion of the rehabilitation activities is recognised as a separate item. The gain/loss is the difference between the actualised rehabilitation cost and the gross accreted value of the expected rehabilitation cost. Any surplus or deficit of cash is attributed to the mining firm.

2.2.3 Implications of financial reporting methods

As stated above, financial reporting for extractive activities requires estimates of reserves or resources in the following cases: (i) under the successful efforts and area of interest methods for accounting for exploration and evaluation costs, estimates of reserves are required to designate a project as successful, and (ii) under the units of production and straight-line methods of amortisation, estimates of reserves are required to allocate amortisation expense across years.

Different accounting methods of capitalising exploration and evaluation expense, as well as different methods of amortising mining property costs, can affect earnings and the book value of equity. When different mining firms apply different accounting policies, the ability to compare their accounting numbers is distorted. Fortunately, the nature of double entry accounting facilitates the combination of affected numbers in order to accommodate for accounting policy differences. Different methods of capitalising/expensing mining items simultaneously affect (a) the capitalised mining assets, deferred exploration and evaluation expenditure, and mining property, on the debit side of the balance sheet,[31] and (b) the retained profits/accumulated losses equity item on the credit side of the balance sheet. By deducting (a) from (b), one can simulate an accounting policy whereby all deferred or brought forward mining costs are fully

[31] Different methods of capitalising/expensing mining items can also affect future income tax benefits on the debit side of the balance sheet. These future income tax benefits may be disclosed but not necessarily recognised on the balance sheet in the early stages of a project if future revenues are not currently expected in the financial accounting sense.

expensed as incurred, *i.e.* the immediate write-off method,[32] or fully expensed as amortisation. By rearranging the balance sheet in this way, one has an accounting equation whereby the book value of equity minus the carrying value of capitalised mining assets equals net working capital (including prepaid assets such as supplies, any future income tax benefits, and financial assets such as the hedge book) minus debt. Net working capital minus debt is the adjustment made in Miller and Upton (1985) to equate the market value of equity with the market value of mining assets.

Another comparison-distorting difference that can exist in the balance sheet of mining firms relates to the extent of progression through the development stage. Progressive development is the principal driver of the capitalised gross value of mining assets. A firm with a project at the beginning of development will have mostly cash and few capitalised mining assets. As the project progresses through the development stage, the level of cash decreases and the capitalised value of the mining assets increases. By deducting estimates of future capital expenditure from both sides of the above accounting equation, one can visualise differences in the extent of progression through the development stage by simulating progressive development. The present value of estimates of future capital expenditure is the adjustment made in the discounted free cash flow valuation model to equate the market value of the firm with the present value of estimated future operating cash flow.

Table 1 provides an illustrative hypothetical example of a firm with different levels of project development (0%, 50% and 100%), capitalisation (0% and 100%) and amortisation (0%, 50% and 100%). Without any adjustments, the figures for book value of equity (Total Equity) differ across the iterations. However, after deducting i) net capitalised mining assets (carrying value) and ii) future capital expenditure, and adding iii) debt, from total assets and total obligations, the resulting number equals the book value of equity for both a) full development with the immediate write-off method (100%, 0%, N/A) and b) full development with full amortisation (100%, 100%, 100%).

[32] A full simulation would also require adjustments for future income tax benefits, depending upon the treatment of such by the individual firm.

2.3 Resource reporting codes

The previous two sub-sections have outlined how resource estimates play an important role in the internal decision making and external financial reporting of mining firms. Although Statement of Financial Accounting Standards (SFAS) 69 in the USA incorporates reserve disclosure within the scope of financial accounting, this requirement only applies to oil and gas activities. To assist interested external parties in the evaluation of a mineral deposit, mining companies disclose estimates of the key characteristics of the resources contained within the deposit, including tonnage and grade. Indicative of the importance of resource estimates to external parties, the importance of the credibility reputation of managers and the public good of overseeing the overall credibility of the mining community, the public reporting of resource estimates is overseen by the relevant professional mining body of that jurisdiction.[33] Each professional mining body issues a resource reporting code that is binding upon its members, as well as requiring resource reporting to be undertaken exclusively by members of a recognised professional mining body. Resource estimation is a highly technical process, requiring significant expertise in geology, statistics and computer modelling, as well as metallurgy, chemistry, engineering, and capital budgeting.

In Australasia (Australia and New Zealand), the relevant professional mining bodies are the Australasian Institute of Mining and Metallurgy, and the Australian Institute of Geoscientists, along with the Minerals Council of Australia (a representative of mining companies). Together these bodies comprise the Joint Ore Reserves Committee (JORC), and their resource reporting code is the JORC Code, first issued in 1989. In the USA, the relevant professional mining body is the Society for Mining, Metallurgy and Exploration (SME), and their resource reporting code is the SME Guide, first issued in 1991. In Canada, the relevant professional mining body is the Canadian Institute of

[33] Pundrich *et. al.* (2013) highlights the similarities and differences between the market for professional resource reporting and the markets for comparable professional services, such as auditing and underwriting.

Mining, Metallurgy and Petroleum (CIM), and their resource reporting code is the CIM Definition Standards, first issued in 2000.

The CIM Definition Standards were released rather late compared to the other two, but this was because a previous resource reporting code existed. In 1983, the Canadian Securities Administrators (CSA, the collection of provincial securities regulatory bodies) issued National Policy Statement (NPS) 2-A “Guide for Mining Engineers, Geologists and Prospectors” overseeing mining property disclosure submitted to the relevant securities regulator. NPS 2-A was not drafted or enforced with the explicit collaboration of the CIM. Following the exposure of the Bre-X fraud in 1997, the CSA undertook an extensive review of NPS 2-A. The outcome of this review was a joint effort between the CSA and the CIM, resulting in the CIM Definition Standards being enshrined in Canadian securities law via National Instrument (NI) 43-101.

After the issue of NI 43-101, Vaughn and Felderhof (2002) compared the resource reporting codes of Canada, Australasia, South Africa, the USA, the UK/Europe, and an international initiative with the support of the UN. Vaughn and Felderhof (2002) conclude that there has been an overall trend towards the harmonisation of these codes. This harmonisation has principally taken the form of substantively harmonised terminology applied in the categorisation of resource estimates. I discuss the main divergence identified by Vaughn and Felderhof (2002), in Section 2.3.3 ‘SEC Industry Guide 7.’

2.3.1 The PRMS

The origin of modern reserve reporting codes can be traced back to the ‘McKelvey diagrams’ attributed to Vincent McKelvey at the US Geological Survey in the 1960s and 1970s. In the context of oil and gas reserves, Figure 1, from the Petroleum Resources Management System (PRMS) and reproduced on page 109, illustrates the basic framework of a McKelvey diagram. In this case, the framework categorises oil and gas reserve estimates based on the consideration of two axes: (i) uncertainty, or geological confidence, and (ii) commerciality, or commercial viability. Commercial viability is categorised as either ‘reserves’ (commercially viable under current conditions; economic, legal, *etc.*), ‘contingent resources’ (may become commercially viable if conditions improve), or ‘prospective resources’ (have not been explored to the extent necessary to measure commercial viability). Geological confidence is estimated from a probability model, where ‘proved reserves’ or ‘1P/C’ have a 90% or greater chance the disclosed quantity will be extracted, ‘probable reserves’ have a 50-89% chance, and ‘possible reserves’ have a 10-49% chance. ‘2P/C’ includes proven and probable reserves (50% or greater chance), while ‘3P/C’ includes proven, probable and possible reserves (10% or greater chance). As prospective resources have not been explored to the extent necessary to quantify geological confidence, estimates of prospective resources are categorised as high, low, and best estimates.

Another distinction that is commonly made in disclosed oil and gas reserves, but not mentioned in Figure 1, is between ‘developed reserves’ and ‘undeveloped reserves.’ As the names suggest, developed reserves have the necessary infrastructure currently in place to extract the reserves, whereas undeveloped reserves do not have this in place currently.[34]

2.3.2 The JORC Code, SME Guide and CIM Definition Standards

Figure 2, from the JORC Code, reproduced on page 110, illustrates the common McKelvey framework for resource reporting codes of hard rock resources. The framework also categorises resource estimates based on the consideration of geological confidence and modifying factors (commercial viability), although on transposed axes.

The JORC Code defines ‘mineral resources’ as “potentially economic” mineral formations that are “known, estimated or interpreted from specific geological evidence

[34] This definition for ‘developed reserves’ from the oil and gas industry is different to the definition for ‘developed resources’ that I apply to gold mining firms (See Appendix: Glossary of technical terms from the extractive industries).

and knowledge."[35] 'Ore reserves' are the *diluted* portion of mineral reserves that are commercially viable under current 'modifying factors.' The JORC Code defines modifying factors as including "mining, metallurgical, economic, marketing, legal, environmental, social and governmental considerations,"[36] *i.e.* factors that affect the current commercial viability of exploiting the deposit. The main determinant of commercial viability is the resource grade(s) *vis-à-vis* commodity price(s) and production costs.

The portion of mineral resources that are not categorised as ore reserves can be categorised as either 'contingent resources'[37] or 'inferred resources.' Contingent resources are the portion of mineral resources that are deemed to be not commercially viable under current commercial conditions.[38] Inferred resources are the portion of mineral resources with geological confidence so low that commercial viability cannot be determined as yet.[39] Although past resource reporting codes, such as NPS 2-A, allowed for the distinction between commercially viable inferred resources ('possible reserves') and commercially unviable, this is not permitted under the current codes (JORC, SME, CIM, *etc.*).

Unlike the PRMS in Figure 1, the JORC Code does not quantify geological confidence. The JORC Code defines three categories of geological confidence; low, reasonable, and high. Low geological confidence relates to situations with sufficient data to "assume" continuity, but both too few in number and too widely spaced to "confirm" continuity. Reasonable geological confidence relates to situations with data sufficient in

[35] JORC Code (2004) §19.
[36] JORC Code (2004) §11.
[37] The term 'contingent resources' is not used in the JORC Code or by the mining industry. The term, borrowing from the PRMS framework, is only used for the purpose of my thesis.
[38] Due to the effect of dilution, the JORC Code emphasises caution when comparing mineral resources with ore reserves. Dilution affects tonnage and grade, but not commodity units.
[39] In the context of resource estimate confidence, the oil and gas literature distinguishes bias and precision (King, 1982; Walther and Evans, 1982; Kahn *et al.*, 1983; Campbell, 1984 and 1988; Alciatore, 1990; Spear and Lee, 1999). However the resource reporting codes make no reference to the concept of bias. Consistent with these codes, my thesis uses 'confidence' as a synonym for precision. I discuss the impact of bias in the form of estimate conservatism in Section 4.4.4.

number, but too widely spaced to confirm continuity. High geological confidence relates to situations with data sufficient in both number and spacing to confirm continuity.[40]

I provide an example of a resource estimate disclosure in Table 2, from the 2008 annual report of Adamus Resource Ltd (ASX: ADU, TSXV: ADU). The COG is 0.8 grams per tonne, but no top-cut is disclosed, apparently because none has been applied. Although not explicitly stated, the mineral resource estimate in the top panel is resources including reserves, as opposed to resources excluding reserves, which means the ounces of contingent resources must be calculated by deducting the ore reserves from the 'measured and indicated' resources, while the tonnage and grade of the contingent resources are not calculable from the information provided in the annual report since the dilution factor is not reported there, but it can be found in the corresponding technical report, which can be accessed through the SEDAR website, and is reproduced on page 116.

The JORC, SME and CIM codes do not prescribe minima for data number or spacing, but rather emphasise the role of the 'competent person' in applying their professional judgment based on prior experience relevant to the geological formation.[41] The codes include a requirement that reports on resource estimates be completed by a competent person named in the report. "A 'Competent Person' must have a minimum of five years' experience which is relevant to the style of mineralisation and type of deposit under consideration and to the activity which that person is undertaking" as well as being a member of a recognised professional mining body. The codes emphasise, and provide additional explanation for, the term 'relevant.' Clearly, the relevance of the competent person's experience translates to the persuasiveness of the modelling techniques, COGs,

[40] The oil and gas reporting codes are based on a similar framework, whereby low confidence is described as "having a chance" of extraction commonly benchmarked at 10% likelihood, reasonable confidence is "reasonably probable" at 50%, and high confidence is "reasonably certain at 90%. Note that in this context the oil and gas framework does not distinguish between geological and economic confidence.
[41] The CIM Definition Standards / NI 43-101 use the term "qualified person" for competent person.

top-cut grades and dilution factor assumptions employed, as well as the delineation of 'sufficient' numbering and spacing of data.[42]

One form of relatively minor divergence in the professional resource reporting codes of Australia, the USA and Canada identified by Vaughn and Felderhof (2002) is the extent that commercial viability must be demonstrated in order to designate mineral resources as ore reserves. Under the JORC Code and SME Guide, designation as ore reserves must be based on "an appropriate assessment" that extraction "could reasonably" be justified, in the opinion of the competent person. This appropriate assessment includes (pre-)feasibility studies, but no type of feasibility study is required to designate mineral resources as ore reserves. However, under the CIM definition standard, the designation as ore reserves must be based on at least a pre-feasibility study. Although the overwhelming majority of ore reserve disclosures in Australia and the USA are based on at least a pre-feasibility study, in the occasional event that this is not the case, a warning is included in the disclosure that the designation of reserves is not compliant with the CIM Definition Standards / NI 43-101.

I provide an example of a typical Australian feasibility study disclosure in Table 3.[43] As (pre-)feasibility studies are not required under the JORC Code / SME Guide, such studies are not defined in the code/guide, and the disclosure content is determined by the management of the mining firm (Ferguson *et al*., 2013). The CIM Definition Standards do define a 'pre-feasibility report' as

> *a comprehensive study of the viability of a mineral project that has advanced to a stage where the mining method, in the case of underground mining, or the pit configuration, in the case of an open pit, has been established and an effective method of mineral processing has been determined, and includes a financial analysis based on reasonable assumptions of technical, engineering, legal, operating, economic, social, and environmental factors and the evaluation of other relevant factors which are sufficient for*

[42] In the case of the Bre-X fraud, the internal manager responsible for the estimates argued that he had discovered a new type of gold formation, as hypothesised in his Ph.D. thesis, with abnormally high grades of gold.
[43] See Ferguson *et al*. (2013) for a discussion of the variation in feasibility study disclosure in Australia, and Section 4.4.5 'Differences in the definition of reserves across resource reporting codes' for a discussion of the implications for my thesis.

a Qualified Person, acting reasonably, to determine if all or part of the Mineral Resource may be classified as a Mineral Reserve.

In contrast to Table 3 disclosed in Australia, the corresponding feasibility study for the same project, as disclosed in Canada under the CIM Definition Standards, includes a thirteen page description of mineral processing and a further twenty-two page description of mining parameters.[44]

The notes in Table 2 refer to a 'technical report' because, in 2008, Adamus was cross-listed on the TSXV, and NI 43-101 requires that a technical report be disclosed within 45 days of disclosing a new mineral resource estimate. These technical reports include key quantitative assumptions utilised in the resource estimation process, including COGs, top-cut grades, and dilution factors, as well as sensitivity tests relating to these assumptions. Technical reports also include sensitivity tests for these assumptions. An example of a sensitivity test relating to the assumed gold price for the reserve disclosures in Table 2 and Table 3 is provided in Table 4, with the highlighted values roughly corresponding to the official gold price assumption and reserve estimate.[45]

Resource and reserve estimates are based on the information available and conditions relating to a given point in time. The JORC Code recommends that when firms change their resource estimates, as information and conditions change, a reconciliation should be provided, although the level of detail expected by JORC is not mentioned in the code. I provide an example of a reserve reconciliation from Golden Star Resources Ltd.'s (NYSE Alternext: GSS) 2008 10-K (annual report filed with the SEC) in Table 5. The difference in the tonnage and ounces between the 2008 and 2007 estimates is allocated between: (a) gold price increases, the revenue side of commercial viability, (b) exploration changes, new geotechnical information improving geological confidence, (c) mining depletion, and (d) engineering, the cost side of commercial viability. Interestingly, although 1.54 million ounces are added to reserves because of gold price increases, 2.7 million ounces are removed because of cost increases, resulting in a net decrease in reserves due to a decline in overall commercial viability.

[44] Adamus Resources Ltd technical report 21/08/08, available from SEDAR.
[45] The exact cause of the discrepancy (over-stating of reserves relative to pit optimisation) is not stipulated.

Although the JORC Code recommends mining firms disclose a reconciliation between *ex ante* production estimates from a feasibility report and *ex post* realised production values, the disclosure of production information itself is not overseen by any of the resource reporting codes. Clearly the purview of the resource reporting codes relates to the formulation and disclosure of mining estimates, not realised outcomes. I provide an example of realised production information from Abelle Limited's (ASX: ABX) 2003 annual report in Table 6. The first panel, Total Mine Production, is distinguished from the second panel, Total Ore Processed as "mine production" here refers to ore extracted from the ground, while "ore processed" refers to ore processed into gold bullion. The third panel highlights an important distinction in the mining industry's supplementary reporting of production costs; 'cash costs' and 'total production costs.' Cash costs do not include depreciation and amortisation, while total production costs do.[46] The reason for this distinction is that total production costs determine the operating profit figure in the profit/loss statement, while cash costs alone are considered 'price-sensitive,' because for valuation purposes, depreciation and amortisation are considered sunk costs of the project.[47] Although not required under resource reporting codes or financial accounting standards, Barrick Gold Corporation (TSX: ABX, NYSE: ABX) discloses a reconciliation between the 'total cash costs' disclosed in their supplementary non-GAAP production information and the 'cost of sales' disclosed in their GAAP income statement, which I provide from their 2008 annual report in Table 7.

[46] Recall that depreciation and amortisation can relate to both deferred cash expenditure (exploration, development, *etc.*) and cash expenditure brought-forward (rehabilitation).

[47] In microeconomic theory, 'sunk cost' means an unavoidable cost. In valuation theory (following the free cash flow model), 'sunk cost' means a historical, non-recurring cost, often providing future net benefits (*i.e.* the present value of the future net benefits, if any, are value-relevant, but not any historical costs incurred to secure those net benefits). Recall that while rehabilitation costs are future costs, they are not necessarily avoidable due to present obligations arising from historical exploration, development and mining activity.

2.3.3 SEC Industry Guide 7

Application of the SME Guide in the USA is subordinate to the regulatory oversight of the SEC. Since 1981,[48] the SEC has restricted the allowed resource estimate categories to just the ore reserve categories. Vaughn and Felderhof (2002) note that "Unfortunately, the SEC rules and regulations are not consistent with the content of the SME Reporting Guide. Instead of adopting the standards developed and recommended by the mineral industry in the US, the SEC follows its own policy."[49]

Until recently, the same SEC restriction applied to oil and gas resources. Boone *et al.* (1998) cites statements by a former SEC Commissioner linking the prohibition on the disclosure of uncommercial oil and gas resources to the need to protect unsophisticated small retail investors. Presumably, the SEC wants to prevent the prohibited resource estimate categories from 'misleading' report users about the commercial viability and ultimate recoverability of the bottom-line total mineral resources estimate. The SEC has lifted this prohibition for oil and gas resources for 2010 onwards,[50] citing improvements in estimation technology; however the prohibition continues for mineral resources.[51]

Mining firms seeking to comply with the SEC restrictions previously reported contingent and inferred resources together as "mineralized material" in text. However, the term 'resource' is explicitly prohibited in this context. Also prohibited is aggregating mineralised material with ore reserves, and aggregating or even tabulating mineralised material across projects. Strangely, disclosing the tonnage and grade of mineralised material is allowed, but disclosing the contained metal, the product of tonnage and grade, is not allowed. More recently, SEC correspondence with individual SEC filers has

[48] Form S-18 Item 17A; now SEC Industry Guide 7 'Extractive Industries' and Regulation S-K Item 102 'Description of Property' Instruction 5.
[49] pp 19-20.
[50] SEC Release No 33-8995.
[51] Although there are obvious similarities between the estimation and disclosure of oil and gas resources and that of mineral resources, there are also key differences. I am unaware of any SEC comment on the distinction between the estimation of oil and gas resources and mineral resources.

demanded the removal of inferred resources estimates from estimates of mineralised material, and thereby implicitly permitting the inclusion of contingent resources.[52]

The term 'mineralised material' is not used in Industry Guide 7. Under the SME Guide, mineralised material typically relates to "fill, pillars, stockpiles, dumps and tailings" – material that is already mined, too low in grade for profitable high recoverability mill processing, but potentially profitable through low recoverability leach processing. SEC correspondence with individual SEC filers has defined mineralised material as ""a mineralized body which has been delineated by appropriate drilling and/or underground sampling to establish continuity and support an estimate of tonnage with an average grade of the selected metals."[53]

Although the prior disclosure of mineralized material appeared to allow mining firms to disclose contingent and inferred resources, some key differences nonetheless apply. First, mineralized material is not explicitly categorised on the basis of geological confidence, as is the case with distinct categories of inferred, indicated and measured resources. Some firms reporting under the SEC code do use footnotes to link their estimates of mineralised material to categories of resources (usually when making their joint venture's estimates from other codes SEC-compliant). Following the informal guidance in SEC correspondence with individual filers, some firms explicitly exclude inferred resources from their estimates of mineralised material. Most firms do not discuss the comparability of their SEC-compliant estimates with other codes. Table 8 summarises key similarities and differences between the JORC Code, the NPS 2-A, the CIM Definition Standards/NI 43-101, and SEC Industry Guide 7.

The SEC Industry Guide 7 exempts mining firms that are required to disclose contingent and inferred resources by foreign law. The SEC has informally emphasised that this exemption was intended for foreign companies, not USA companies (SME,

[52] *e.g.* correspondence with Coeur d'Alene Mines Corporation (NYSE: CDM, TSX: CDM, ASX: CXC) on 30/04/08, 12/06/08 and 11/07/08, and with Aurora Gold Corporation (OTCBB: ARXG) on 07/09/11.
[53] Correspondence with Coeur d'Alene Mines Corporation (NYSE: CDM, TSX: CDM, ASX: CXC) on 30/04/08.

2012). This exception has motivated some early-stage USA mining firms to re-domicile to Canada. The SEC has also informally emphasised that required by 'law' does not include professional bodies or even stock exchange listing rules (SME, 2012). While the SEC has informally agreed that NI 43-101 is a law, the SEC has not commented on the JORC Code, which, although produced by a professional body, is enshrined in the ASX Listing Rules, which are themselves enshrined into Australian Corporations Law.

For example, Vista Gold Corp (AMEX: VGZ, TSX: VGZ) is an SEC filer, headquartered in Colorado, listed on the AMEX and TSX. Up to and including 2002, Vista's estimates of mineralised material in the 10-K annual reports were an aggregate of inferred, indicated and measured resources. From 2003 onwards, Vista's estimates of mineralised material in the 10-K annual reports excluded inferred resources (*i.e.*, indicated and measured only). After 2001, Vista also disclosed technical reports through SEDAR which followed NI 43-101 and divided resource estimates into separate categories of measured, indicated, and inferred. Throughout all this time, resource estimates disclosed by joint venture partners (such as Silver Standard Resources Inc., headquartered in British Columbia, TSX(V): SSO, NASDAQ: SSRI) for the same projects was also divided into separate categories of measured, indicated, and inferred.

The SEC also requires that the identification of ore reserves be based on a full feasibility report. It is understandable that the SEC would reinforce its restrictive regulation of reserve disclosure with a restrictive definition of reserves. However, SEC Industry Guide 7 does not include a definition of a full feasibility report, although a non-exhaustive list of components is provided.[54] The SEC staff follow an *ad hoc* case-by-case assessment of whether individual feasibility reports satisfy their own understanding of a 'full feasibility report.' It is possible to infer some definitional factors from past SEC decisions. For example, the SEC stresses finalised mining permits are a requirement for a full feasibility report (SME, 2012). However, the tendency for the SEC to prosecute large firms, which tend to be producers, leaves significant ambiguity for developers and explorers.

[54] Geological and topographical maps, drill data, and calculations.

Vaughn and Felderhof (2002) discuss the case of the Veladero project in Argentina and the related Barrick-Homestake merger. The Homestake Mining Company (NYSE: HM; ASX: HSM; SIX: HM) was the manager and 60% stakeholder in the Veladero exploration project, with Barrick as the residual 40% stakeholder. In March 2001, for the first time, Homestake reported a reserve estimate for the Veladero project. Barrick, reporting under CIM Definition Standards / NI 43-101, reported the same reserve estimate, and classified the mineralised material as indicated resources. In June 2001, Barrick and Homestake announced their intention to merge, which would require SEC approval. At some point, the SEC informed Homestake that its Veladero reserves should be downgraded to mineralised material because of non-finalised mining permits. Homestake and Barrick both complied with the SEC's decision, re-issuing amended annual reports in November 2001, including the corresponding accounting adjustments. The merger was completed in December 2001. Barrick's 2001 annual report, released in April 2002, reintroduced reserve estimates for the Veladero project, including a comparison to the prohibited 2000 estimates.

Vaughn and Felderhof (2002) also discuss the case of the Stillwater Mining Company (NYSE: SWC; TSX: SWC). For sixteen years, Stillwater had continuously hired an independent mining consulting company to estimate its reserves, which followed the same methodology each year. However in April 2002, the SEC informed Stillwater that its 27.7 million ounces of probable reserves should be downgraded to mineralised material because the drill hole data were too widely spaced to confirm continuity of the mineralisation, leaving only 2.2 million ounces of proven reserves. Following the SEC's decision would cause Stillwater to significantly revise its amortisation expense up to the point of breaching a debt covenant. The independent mining consulting company hired by Stillwater hired another independent mining consulting company to review the classification, and this company also agreed with Stillwater. After Stillwater appealed the SEC's decision, a settlement was reached whereby only 2.2 million ounces of probable reserves were downgraded to mineralised material. Although Stillwater did not thereby breach the debt covenant, it did pay a $720,000 penalty to the SEC for a January 2002 private placement disclosing the original reserve estimate.

The curious disclosure situation faced by mining firms simultaneously listed in both the USA and elsewhere is described in the lengthy legalistic fine print of a footnote to the table of mineral resource estimates, based on CIM Definition Standards / NI 43-101, from Barrick's 2008 annual report:

> *Mineral reserves ("reserves") and mineral resources ("resources") have been calculated as at December 31, 2008 in accordance with National Instrument 43-101 as required by Canadian securities regulatory authorities. For United States reporting purposes, Industry Guide 7, (under the Securities and Exchange Act of 1937) as interpreted by the staff of the SEC, applies different standards in order to classify mineralization as a reserve. Accordingly, for U.S. reporting purposes, [all reserves of] Cerro Casale [are] classified as mineralized material and approximately 600,000 ounces of reserves for Pueblo Viejo (Barrick's 60% interest) are classified as mineralised material. In addition, while the terms "measured", "indicated" and "inferred" mineral resources are required pursuant to National Instrument 43-101, the U.S. Securities and Exchange Commission does not recognize such terms. Canadian standards differ significantly from the requirements of the U.S. Securities and Exchange Commission, and mineral resource information contained herein is not comparable to similar information regarding mineral reserves disclosed in accordance with the requirements of the U.S. Securities and Exchange Commission. U.S. investors should understand that "inferred" mineral resources have a great amount of uncertainty as to their existence and great uncertainty as to their economic and legal feasibility. In addition, U.S. investors are cautioned not to assume that any part of all of Barrick's mineral resources constitute or will be converted into reserves.*

The above example is typical of the boilerplate caution accompanying the mineral resource estimates of cross-listed mining firms. The SME notes that the SEC does allow all filers to disclose resource estimates through informal channels (*i.e.*, not SEC filings) as long as a similar caution to above for 'U.S. investors' is included. While disclosure outside of SEC filings can provide a means for firms to communicate resource estimates, the lack of consistency across disclosure documents hurts transparency. Mindful of the SEC's *ad hoc* investigation of disclosure based on their poorly defined rules, USA mining firms are naturally reluctant to exploit informal channels to circumvent the SEC.

3.0 Hypotheses

The disclosure of resource estimates can be characterised along different lines of disclosure theory. Resource disclosure includes elements of supplementary disclosure, voluntary disclosure, and regulated disclosure. Supplementary disclosure is disclosure that supplements the GAAP numbers mandated and regulated by financial reporting standards.[55] Voluntary disclosure is disclosure that is not mandated, in the sense that the decision to disclose or not disclose is voluntary, but may nonetheless be regulated. Regulated disclosure is disclosure with regulatory restrictions relating to the choice in the manner of disclosure.[56] These three dichotomies overlap in many regards, but offer unique insights into the theory and practice of disclosure. These insights provide context for assessing the utility of the disclosure of resource estimates and, by extension, the corresponding impact of the restriction of such disclosure.

After discussing the factors that encourage and restrict the disclosure of resource estimates, I then discuss the factors that encourage and permit the revision of resource estimates. It is the uncertainty in the presence or absence of these determinants that drives the uncertainty in whether or not estimates of uneconomic resources will be converted into reserves.

3.1 Resource disclosure as supplementary disclosure

> *All financial reporting is concerned in varying degrees with decision making (though decision makers also use information obtained from other sources). The need for information on which to base investment, credit, and similar decisions underlies the objectives of financial reporting.*
>
> SFAC 2 "Qualitative Characteristics of Accounting Information" p1.

[55] Some literature refers to supplementary information as 'non-financial information.' I believe this label can be misleading because it implies the information is not measured in monetary amounts, as distinguished from GAAP-based financial reporting.
[56] Some literature labels the choice in the manner of disclosure as a form of 'voluntary' disclosure in addition to the choice to disclose or not disclose.

For most firms, financial reporting (GAAP numbers) is an important source of information for the decision making of capital providers (investors and creditors; Basu *et al.*, 2010). Capital providers examine the levels and changes in GAAP numbers to forecast future cash flows and their probability distribution. However, due to 'user-specific factors' in the decision usefulness of GAAP numbers (SFAC 2), principle trade-offs are made in financial reporting. For objectivity and other considerations, GAAP numbers are often based on historical cost rather than estimates of current market value.[57] To improve the ability for GAAP earnings to represent 'true' performance, GAAP numbers are somewhat based on the matching principle, matching costs with revenues, although other principles can interfere, such as the conservatism principle.[58] "Though, ideally, the choice of an accounting alternative should produce information that is both more reliable [including objective and conservative] and more relevant [including current and 'matched'], it may be necessary to sacrifice some of one quality for a gain in another" (SFAC 2 p2).

The sacrifices in financial reporting are particularly difficult for DSEs. As DSEs can take multiple years to reach the revenue generating stage, involving considerable risk, the matching principle sharply conflicts with the conservatism principle at this stage. Years of cash expenditure can accumulate before the addition of value is reflected in a market transaction. The choice between applying the successful efforts and full cost methods for accounting for exploration costs is partly a reflection of the choice between favouring the conservatism and matching principles respectively (Cortese *et al.*, 2009).

Firms voluntarily disclose supplementary information, in addition to GAAP numbers for two reasons: informativeness and opportunism (Beyer *et al.*, 2010). The informativeness of disclosure (GAAP-based and supplementary) has at least two aspects.[59] First, the informativeness of disclosure relates to information used by capital

[57] Although fair value accounting provide a means to recognise current values.
[58] The conservatism principle is defined and discussed further in Section 4.4.4 'Estimate conservatism.'
[59] While some might argue that stewardship is another role for historical GAAP numbers of interest to investors beyond forecasting/valuation, I would argue that investors' oversight of management occurs

providers to assist in distinguishing between the GAAP earnings that are permanent and transitory. However, opportunistic managers might disclose supplementary information to obscure, or draw attention away from, the nature of the firm's permanent earnings (*e.g.*, the Bre-X fraud). For opportunism to succeed, it is necessary that capital providers struggle to distinguish between permanent and transitory earnings, *i.e.*, earnings be naturally less informative for that type of firm, as well as struggle to distinguish between informative and opportunistic supplementary disclosure, due to information asymmetry and agency cost issues.

The second aspect of informativeness relates to the synergistic relation between timely disclosure and reliable disclosure. Ball and Brown (1968) commented that GAAP earnings will be informative if either a) they are a timely source of information (earlier than other sources), or b) they provide a reliable source of confirmation (for earlier sources of lower reliability). Supplementary disclosure often acts as a timely source of early information, to which GAAP numbers acts as a reliable source of later confirmation (Beyer *et al.*, 2010).[60]

Just as the limitations of GAAP numbers are particularly difficult for DSEs, the incremental usefulness of supplementary information is particularly beneficial for DSEs (Ferguson *et al.*, 2011a; Ferguson *et al.*, 2013). Supplementary information is important for DSEs in technology-based industries, such as e-commerce (Trueman *et al.,* 2000; Demers and Lev, 2001) and research and development (Matolcsy and Wyatt, 2008). While the GAAP numbers of DSEs focus on objectivity and conservatism, supplementary information can focus on timeliness and currency.

through the market for corporate control, which itself operates through investors' trading activity. In other words, while it is possible to view financial accounting through separate lenses of forecasting/valuation and stewardship, the two concepts are related. I recognise that, beyond investors, other users of earnings and supplementary information have different uses for this information and different interests in its disclosure.

[60] It is the historical tendency for early supplementary disclosure being confirmed by GAAP numbers that forms the basis for the reputation effects referred to elsewhere in my thesis.

Resource disclosure is a form of supplementary disclosure as it is not within the scope of GAAP,[61] although resource disclosure can have consequences for GAAP numbers, as discussed in Section 2.2 'Financial reporting.' Resource disclosure is of vital importance for mining DSEs as a means to assist GAAP numbers in communicating 'true' performance (Ferguson *et al.*, 2013). Resource disclosure involves the disclosure of supplementary information that facilitates the forecast of future cash flow. In the case of mining DSEs, resource disclosure facilitates the forecast of the future performance of projects currently in development. In the case of producing firms that do earn revenues, resource disclosure facilitates the forecast of the exhaustion of projects currently in production. For all extraction projects, the persistence of earnings derived from resources is limited by the characteristics of those resources.

Magliolo (1986) investigated the price-sensitivity of the book values of proven oil and gas reserves and probable oil and gas reserves, as well as reserve-based and analyst-based estimates of intrinsic values. Magliolo (1986) predicted that the estimates of intrinsic value would dominate the book values of reserves, but the book values would still capture tax benefits associated with their depreciation and amortisation. The results varied across years, possibly due to movements in the oil and gas prices, but suggested that both the intrinsic values and the book values were price-sensitive. Harris and Ohlson (1987) extend Magliolo (1986) by separating book values into the successful efforts and full cost accounting methods for exploration and evaluation expenditure. Once again, the results varied across years, but suggested a difference in the price sensitivity of book values from the two methods. Bryant (2003) attempts to explain the result in Harris and Ohlson (1987) by estimating and analysing the difference between the two accounting methods for each firm-year observation. Bryant (2003) reports more explanatory power for full cost GAAP numbers, but attributes this result to their greater smoothness. Zhou *et al*. (2011) investigate the price-sensitivity of Australian mining firms' area of interest GAAP numbers. Zhou *et al*. (2011) reports significant price-sensitivity for the GAAP numbers, but does not include any intrinsic values, such as reserve-based estimates.

[61] Although SFAS 69 does require reserve disclosure for oil and gas firms. IFRS 6 may in time include reserve disclosure, but not currently.

In summary, the disclosure of resource estimates, and related geotechnical information, supplements the disclosure of the GAAP financial statements by mining firms. On the one hand, the relevance of the estimates to industry analysts is high, for both DSEs and established producers, and facilitates the assessment of underlying performance and the forecasting of future performance and expected risk. On the other hand, the highly technical basis for the estimates can, on the rare occasion, be exploited to obscure performance, e.g. the Bre-X fraud.

3.2 Resource disclosure as voluntary disclosure

While all GAAP numbers are mandated disclosure by definition, some supplementary disclosure is mandated (*e.g.* certain corporate governance information), while some is voluntary. The Australian Stock Exchange (ASX) and the Canadian Securities Administrators (CSA) have enacted continuous disclosure policies,[62] requiring firms to disclose price-sensitive information on a timely basis through a centralised system. In other words, continuous disclosure policies require firms to disclose information that is useful to investors' decision making, as early as possible (while the information is still useful, but subject to some consideration of cost and accuracy), without preference for certain investors. These continuous disclosure policies have the effect of requiring mining firms to disclose their resource estimates on a timely basis, including estimates of contingent and inferred resources. Therefore, in Australia and Canada, resource estimates are a form of supplementary information that is considered so important to decision makers that its disclosure is mandatory.[63]

In the USA, however, while the SEC does have *Regulation Fair Disclosure* and many other disclosure regulations, the SEC has no explicit continuous disclosure regulation. While similarities and differences in disclosure regulation across jurisdictions

[62] Chapter 3, ASX Listing Rules; NI 51-102 "Continuous Disclosure Obligations."

[63] Technically, if a mining firm never generated or acquired a resource estimate, it would not be required to disclose information it does not possess. Resource estimation is hypothetically not absolutely necessary to develop and run a mine, although not estimating the reserves prior to development would involve considerable risk.

can always be discussed, the simple reality is that the SEC has (for the moment) chosen not to enact an explicit continuous disclosure regulation. While SFAS 69 requires oil and gas producers to disclose estimates of oil and gas reserves, there is no such requirement within Industry Guide 7 for either mineral producers or DSEs from any extractive industry. SEC filers therefore have a choice between four options: (i) disclose no estimates, (ii) disclose estimates of reserves only, (iii) disclose estimates of reserves and mineralised material separately, or (iv) disclose estimates of total resources (as mineralised material).

Beyer *et al.* (2010) outline the common economic incentives and disincentives that influence managers' decisions to disclose information. Craswell and Taylor (1992) provide weak evidence that these incentives and disincentives, such as information asymmetry between managers and investors, and agency costs, create a demand for resource estimates which does influence managers' decisions. Mirza and Zimmer (2001) extend Craswell and Taylor (1992) by including factors relating to the supply of disclosure, such as project operational complexity and milestones.

The main incentive to publically disclose information is to reduce the firm's cost of capital / increase access to new capital, by reducing information asymmetry and increasing secondary market liquidity. Disclosure can reduce the information asymmetry between managers and investors, which improves the ability for investors to monitor the managers' performance, reducing agency costs and the cost of capital charged by investors employing price-protection (Shleifer and Wolfenzon, 2002). While Bens (2002) argues that public disclosure facilitates the ability for providers of public capital to monitor managers, Bushman *et al.* (2004) argue that internal monitoring can act as a substitute for public disclosure. In the context of mining DSEs, Ferguson *et al.* (2013) emphasises the high level of information asymmetry between managers and investors due to the lower informativeness of GAAP earnings for these firms, while Ferguson *et al.* (2011b) document the lower level of internal and external monitoring associated with small development-stage firms from all industries, highlighting the strong demand amongst investors for voluntary disclosure from mining firms (Brown *et al*., 2013).[64]

Disclosure can reduce the information asymmetry between individual investors, also reducing the cost of capital charged by investors employing price-protection (Diamond, 1985; Easley and O'Hara, 2004), although the information asymmetry between individual investors may be diversifiable and thus not affect the cost of capital (Hughes *et al.*, 2007). Disclosure can improve the ability of investors to distinguish between diversifiable and non-diversifiable risks, and thereby reduce the cost of capital (Lambert *et al.*, 2007). Poskitt (2005) emphasises the high level of information asymmetry between individual investors of mining firms, highlighting the strong demand among investors for public disclosure from mining firms.

Even if reducing the information asymmetry between individual investors does not directly reduce the cost of capital, due to the diversifiability of these direct effects, if reducing the information asymmetry between individual investors improves liquidity, disclosure can reduce the cost of capital by improving liquidity (Amihud and Mendelson, 1986). Ferguson and Scott (2011) address the possibility of a high level of non-synchronous trading of the stock of small mining DSEs, highlighting the strong demand amongst investors for new information from mining firms.

Besides the cost of producing the disclosure, which is incrementally small if the information was already generated for internal purposes, the main cost of public disclosure is the proprietary cost associated with divulging business information to competitors (Verrechia, 1983; Verrechia and Weber, 2006). In situations of significant proprietary costs, it may be in the best interests of investors for managers not to publically disclose the information. Ferguson *et al.* (2013) emphasise the low level of proprietary costs for resource disclosure due to the nature of the exclusive rights granted under tenement licenses. However, Ferguson and Crockett (2003) examine how the resource disclosure of a firm in one tenement can create information transfers for

[64] I discuss the nature of resources disclosure as supplementary to GAAP earnings in Section 3.1.

neighbouring tenements which may be owned by rival firms. The public disclosure of favourable resource estimates will increase the price that the manager would have to pay to acquire unexplored neighbouring tenements, reflecting a proprietary cost.

At first, managers may postpone the disclosure of unexpectedly positive prospecting results until they have secured the rights to neighbouring tenements. Later, the high dependence of small mining DSEs on raising significant new capital to fund development (Ferguson *et al.*, 2011a) will prompt managers to disclosure the good news. Some managers of small DSEs seek private debt or equity capital funding, although private disclosure and trading on insider information is illegal. While large producing mining firms may have the funds on hand to fully exploit proprietary information about exploration results, due to differences in their risk profile, large firms tend to be less involved in the exploration of green-field tenements.

A cost of public disclosure that is also being considered in recent research is the real effects cost. The real effects cost of public disclosure exists when public disclosure causes the managers or capital providers of a firm to alter their decisions in a manner that is not in the best interests of the disclosing firm. For example, Goldstein and Sapra (2012) emphasise a real effect cost of disclosing the results of banks' stress tests. If a bank performs poorly, while a given individual depositor may not expect the bank to close, that depositor may anticipate other depositors expecting the bank to close, and therefore the original depositor will withdraw their deposits before the other depositors run on the bank, thereby contributing towards a run on the bank.

Grosse *et al*. (2013) document large abnormal returns for mining DSEs that disclose successful development financing arrangements. If a DSE discloses mildly bad news for a project, while a given individual investor may not expect the project to ordinarily close due to an inability to acquire development financing, that investor may anticipate other investors expecting the project to close, and therefore the original investor will sell their shares before the other investors sell. If arbitrage cannot prevent the price from dropping substantially, the cost of capital will increase to such an extent as to prevent the new capital raising necessary to fund the project's development and the project will close. The downward price impact is exacerbated when selling illiquid assets (Plantin *et al.*, 2008) such as the shares of small mining DSEs.

Overall, the managers of SEC-filing mining firms have clear incentives to voluntarily disclose resource estimates. Such disclosure reduces the highly technical information asymmetry (between managers and investors, and between individual investors), complements shareholder monitoring as a substitute for low internal monitoring, reduces agency costs, increases the liquidity of what can be thinly traded shares, reduces the cost of capital and increases access to new capital for capital-dependent DSEs.

3.3 Resource disclosure as regulated disclosure

Beyond mandating certain disclosure (restricting the choice of whether or not to disclose), the regulation of disclosure can also restrict the manner in which (mandatory or voluntary) disclosure is made. The disclosure of all GAAP numbers is regulated by the relevant financial reporting standards. In contrast, some supplementary disclosure is regulated, some is not.

Given the importance of resource disclosure as supplementary information for extraction firms, and to address concerns over the possibility that some managers might disclose resource estimates in an opportunistic/misleading fashion, the disclosure of resource estimates is regulated. In Australia (since 1989), the USA (since 1991) and Canada (since 2000) the disclosure of resource estimates has been regulated by the relevant professional bodies within these countries. The professional bodies have published and revised resource reporting codes, and these codes are binding upon their professional members. All three codes require resource disclosure to be undertaken only by members of a recognised professional body. As the various professional bodies have revised their codes towards harmonisation, the codes rigorously restrict the terminology employed in resource disclosure.

In Australia, the local code has been incorporated into the Listing Rules of the ASX,[65] which are themselves incorporated into Australian securities law by the enacting legislation of, and therefore overseen by, the Australian Securities and Investments Commission. In Canada, the local code has been incorporated into national securities law by the CSA.[66]

Public confidence in the reliability of resource estimates has been shaken from time to time. Exaggerating the situation, Mark Twain once jokingly described a mine as "a hole in the ground owned by a liar."[67] In an extreme example, the Bre-X fraud in 1997 demonstrated how managerial ownership can create incentives for managers to misrepresent reserve estimates (Brown and Burdekin, 2000). A market for these 'holes in the ground' would be similar to the theoretical market for lemons described in Akerlof (1970), whereby honest managers of commercially viable deposits would be indistinguishable from the liars, and would therefore exit the market. In reality, such liars are a rare occurrence. Nonetheless, honest managers of commercially viable deposits have strong incentives to be (relatively) honest, and they utilise disclosure credibility mechanisms to signal the commercial viability of their deposits. Spence (1973) discusses how credible signals must be selective (both informative and costly to implement). In the context of the reporting of mineral resource estimates, the principal disclosure credibility mechanism is the application of resource reporting codes, by a competent professional, to the mineral resource estimates.

Resource reporting codes assess reliability on two bases: geological confidence and commercial viability. Geological confidence refers to the level of confidence relating to the number and spacing of the drill holes used as inputs in the estimation process. Commercial viability refers to the profitability of exploiting the reserves within the deposit under current economic and legal conditions, as well as other 'modifying factors.'

[65] Chapter 5, ASX Listing Rules. The ASX also issues 'companies updates' in relation to its interpretation of the JORC Code *vis-à-vis* the reporting practice of listed companies.
[66] NI 43-101 "Standards of Disclosure for Mineral Projects."
[67] *The Autobiography of John Hays Hammond* (Farrar and Rinehart, 1935), p. 97.

A graphical representation of the resource estimate categories is presented in Figure 3, which follows Figure 2 with geological confidence on the Y-axis and commercial viability on the X-axis. Figure 3a provides the standard classification as contained in the JORC Code, SME Guide, and CIM Definition Standards / NI 43-101, with five categories in total. Figure 3b provides the SEC Industry Guide 7 classification, with the five categories reduced to three (proven reserves, probable reserves and mineralised material). Figure 3c provides a simplified classification, forming the basis for my thesis, with the five categories reduced to three (ore reserves, contingent resources and inferred resources). Figure 3d, also utilised in my thesis, reduces the three categories to two (inferred resources and developed resources) by removing the commercial viability axis.

Within the context of geological confidence, advanced estimates are precise, because they are based on a large number of closely spaced inputs, but untimely because improving the set of inputs requires a considerable amount of time. Preliminary estimates, on the other hand, are timely because they are disclosed early, without requiring a considerable amount of time to develop, but imprecise because they are based on a small number of widely spaced inputs. The disclosure of preliminary estimates can convey information about future developed resources in a timely fashion, albeit with lower accuracy.

Within the context of commercial viability, estimates of ore reserves have representational faithfulness of future extraction, because reserves are explicitly limited to present commercial viability, but may not be timely because improvements in commercial viability can take time. Estimates of contingent resources are timely because the estimates include resources that, while commercially unviable now, may become commercially viable in the future, but have low representational faithfulness of future extraction, because the estimates include resources that are presently commercially unviable. Preliminary estimates (inferred resources) are timely, but have low representational faithfulness of future extraction, because commercial viability is not yet disclosed.[68] The disclosure of estimates of contingent and inferred resources can convey timely information about future reserves, albeit with lower accuracy. To what extent the utility of the timeliness of estimates of contingent and inferred resources exceeds the uncertainty is an empirical question.

> H_{1a}: *Estimates of contingent resources and estimates of inferred resources are positively associated with the future change in reserve estimates.*[69]

The situation in the USA is somewhat different to Australia and Canada. Although the professional mining body in the USA has a reporting code, the SME Guide, the national securities regulator (the SEC) has heavily restricted the ability of firms to follow the SME Guide. Recall that the SEC has prevented the disclosure of estimates of contingent and inferred resources because of its concerns that uncommercial and less reliable estimates may 'mislead' some investors. Boone *et al.* (1998) cites statements by a former SEC Commissioner linking the prohibition on the disclosure of uncommercial resources to the need to protect small unsophisticated retail investors.

Recall that all three professional bodies prohibit the disclosure of 'possible' reserves by mining firms (but allow this for oil and gas firms). Possible reserves are the economically viable portion of inferred resources. The justification given by the JORC for this prohibition is that, by definition, inferred resources lack sufficient geological certainty for an assessment of economic viability to be meaningful. The professional bodies therefore implicitly recognise that, under certain conditions, even reserve estimates can be misleading. This makes for an interesting contrast to the SEC's position that uneconomic resource estimates can be misleading.

While it is accepted in the academic literature that estimates of ore reserves, and possibly mineral resources, are used by investors to value mining firms, different explanations have been offered for which estimates are used and how they are used.

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[68] Such disclosure is prohibited. However, prior to NI 43-101 in 2001, the distinction between commercially viable 'possible reserves' and unviable 'inferred resources' was permitted under NPS 2-A.

[69] I provide a graphical representation of H_{1a} in Figure 4a.

Hotelling (1931) offers a simple model to express resource company market value as a function of ore reserve characteristics, based on Hotelling's rule.[70] Hotelling's rule argues that, in equilibrium, at the industry and firm level, reserve marginal profit (spot price minus marginal production costs) per unit increases at the rate of the cost of capital. If a firm's profit grows more (less) than the cost of capital, the firm will increase (decrease) production, assuming diminishing marginal rates of return, until the growth in marginal profit equals the cost of capital. It is important to note that Hotelling's rule refers to forward-looking marginal profit, not backward-looking average profit (Miller and Upton, 1985).

Miller and Upton (1985) derive an empirical form of Hotelling's rule, known as the Hotelling Valuation Principle (HVP). Starting with the present value of a finite series of operating cash flows of an extraction firm, similar to the discounted free cash flow model,[71] the HVP utilises Hotelling's rule to reduce the equation. Under the simplest version of the HVP,[72] the growth in the marginal profit (the numerator) equals the discount rate (growth in the denominator) in the net present value calculation, and therefore the net present value of a project's reserves is equal to the product of the quantity of reserve units and the marginal profit per reserve unit. Just as the marginal profit per unit grows at the discount rate, so too does the net present value of the project, regardless of whether the reserves are extracted or left in the ground.

Consistent with the views of the SEC, the simple HVP implies that contingent resources are not value relevant in the long-term, because the change in the commodity price is offset by an equal change in the production cost. The simple HVP assumes no new discoveries of inferred resources, and no development of inferred resources into

[70] Hotelling's rule (also known as Hotelling's principle) extends from Hotelling's lemma, which broadly relates level of supply to profit maximisation in the context of exhaustible resources. Not to be confused with Hotelling's law (relating to the tendency towards similarity among competitors) or Hotelling's t distribution (a generalisation of Student's t distribution).

[71] See Ohlson (1995) and Ohlson and Juettner-Nauroth (2005) for a reconciliation between the discounted dividend model, discounted free cash flow model, and the Ohlson (1995) discounted residual income model.

[72] I discuss practical (as opposed to conceptual) developments of the HVP in Section 4 'Research Design.'

reserves. Therefore the simple HVP does not support the disclosure of estimates of contingent and inferred resources.

As the simple HVP assumes that future marginal profit will equal future average profit, future production costs are assumed to move with the spot price, and thus future production costs are assumed to be independent of extraction levels. As the per unit extraction costs of oil, and to a lesser extent gas, are known to increase as well pressure declines due to accumulated extraction, the intuition form the oil industry rejects the assumption that future production costs are independent of extraction levels. Miller and Upton (1985) extend the HVP to accommodate production costs that increase with extraction.

Krautkraemer (1998) points out that applying the Miller and Upton (1985) notion of oil and gas diminishing profits to the hard rock setting is problematic. Rather than being subject to well pressure, hard rock deposits are subject to heterogeneous grade (commodity units per tonne of ore). Cost per mineral unit increases as the grade decreases because costs are driven by the tonnes of ore being extracted and processed. Krautkraemer (1998) suggests that calculating the optimal extraction scenario for hard rock deposits involves simultaneously calculating the optimal extraction pit (delineating reserves from contingent resources) and the optimal production rates (extraction and processing). The optimal extraction pit and rate equate marginal benefit with marginal cost.

If marginal revenue equals marginal cost, the optimal minimum grade of the pit,[73] which delineates reserves from contingent resources, is equal to the production cost per ton/tonne divided by the spot price per ounce/gram. If the industry growth in production cost per ton/tonne is less than the industry cost of capital, and the demand curve for the commodity is stationary, the spot price will grow at less than the cost of capital, and firms' pits will expand, and grade will decrease, over time, subject to expansion costs. If

[73] Referred to as 'cut-off grade' by Krautkraemer (1998), but this term has a different meaning in the mining industry.

the long-term equilibrium industry profit margin (profit per ounce/gram divided by spot price per ounce/gram) is assumed to be constant, due to players entering and exiting the industry, then the spot price, cost and profit per ounce/gram all increase at the cost of capital, and the decrease in the pit grades will equal one plus the inflation rate divided by one plus the cost of capital.

The main ramification of a systematically declining reserve grade is that resources that were not commercially viable in the past may become commercially viable in the future, and thus contingent resources are price-sensitive, consistent with the views of the SME. A positive value for contingent resources also improves the value of inferred resources, as developing inferred resources will be reclassified as either reserves or contingent resources. Therefore an extended HVP along the lines of Krautkraemer (1998) supports the disclosure of estimates of contingent and inferred resources.

Given a long-term trend for declining reserve grade (increasing commercial viability of contingent resources), as well as medium-term volatility in spot prices and production costs, Brennan and Schwartz (1985) suggest applying options valuation techniques to value estimates of contingent and inferred resources. Just as the Black and Scholes (1973) options valuation model demonstrates how out-of-the-money options have a positive implicit value, Brennan and Schwartz (1985) argue contingent resources with even the smallest commercial potential have a corresponding positive implicit value. Moel and Tufano (2002) provide empirical evidence of a positive market value for uncommercial deposits, based on proxies for the deposits' probability of future commercial viability. Under the Brennan and Schwartz (1985) real options model, estimates of contingent resources are clearly price-sensitive. Brennan and Schwartz (1985), Paddock *et al.* (1988), and Colwell *et al.* (2002) suggest a nested real options model to value unexplored tenements and preliminary estimates (inferred resources), *i.e.*, a discovery option within a commercial viability option. The real options approach supports the disclosure of estimates of contingent and inferred resources.

As mentioned in Adam and Goyal (2008), although the literature suggests using a real options approach to value mineralised material, the information required to do so properly is not publically available. Both the probability distribution and related effects of exploration success are unknown. Paddock *et al*. (1988) expands on the Brennan and Schwartz (1985) method for valuing an undeveloped project as a real option, but this requires information on the value and volatility of the underlying asset, the value of the project if it were developed into an operating state. However, problems emerge even when applying a real options approach to the valuation of reserves in an operating mine. The simplified approach in Adam and Goyal (2008) utilises extraction costs in the previous year, even though these costs can vary with well pressure (for oil and gas) or ore grade (for hard rock). Even if well pressure/ore grade is not assumed to be constant, if the commodity price changes, the delineation of marginal resources as commercial or uncommercial will change and therefore the sensitivity of reclassification to commodity price changes is required for the real option valuation.

The international differences in resource reporting codes appear to correspond with differences in assumptions about the appropriate valuation model. Consistent with the simple HVP, the SEC encourages the disclosure of estimates of ore reserves, but severely restricts the disclosure of uncommercial and preliminary estimates, presumably because unsophisticated investors may be 'misled' if they fixate on aggregate resources. However, the SEC allows an exception for companies listed on foreign exchanges that require the disclosure mineral resource estimates. Consistent with the extended HVP and the real options model, the JORC Code and NI 43-101 are far less restrictive regarding the disclosure of uncommercial and preliminary estimates, presumably because sophisticated investors can distinguish between the different types of mineral resource categories and these differences are important in their valuation of mining projects.

The ASX and CSA require the timely disclosure of estimates of contingent and inferred resources because these estimates are price-sensitive. Although, by definition, estimates of contingent resources are not commercially viable today, all resource estimates must be 'potentially economic.' As conditions change, a portion of contingent resources may become commercially viable in the future and therefore be reclassified as reserves. As reserves are price-sensitive, and a portion of contingent resources may become reserves, estimates of contingent resources are price-sensitive. Similarly, as inferred resources are further explored, and the number and spacing of data points are developed to improve reliability of estimate continuity, the estimates are reclassified as either reserves or contingent resources, depending upon commercial viability. As developed resources (reserves and contingent resources) are price-sensitive, and inferred resources are reclassified as developed resources, estimates of inferred resources are price-sensitive.

Prior research has ignored the issue of the price-sensitivity of contingent resources, focusing instead on oil and gas estimates. Berry and Wright (1997) report evidence that estimates of *oil* reserves and estimates of *gas* reserves are both price-sensitive, but with significantly different co-efficients. Similarly, Donker *et al.* (2006) report evidence that estimates of oil and gas *proven* (90-100% confidence) and *probable* (50-89% confidence) reserves are both price-sensitive, but with significantly different co-efficients (although the lowest level, *possible* reserves, is not tested). Berry and Wright (1997) and Berry *et al.* (1997) report evidence that while estimates of *developed* oil and gas reserves are price-sensitive, estimates of *undeveloped* oil and gas reserves are not price-sensitive.[74] The hard rock research has naively interpreted this result as implying that only estimates of hard rock *reserves* are informative, without explicitly testing the estimates of contingent and inferred *resources* (*e.g.* Moel and Tufano, 2002; Ferguson *et al.*, 2013). Brown *et al.* (2007) include estimates of total resources in their analysis, making no distinction between reserves, contingent and inferred resources.

Despite the prior oil and gas research that has reported evidence explicitly against the price-sensitivity of estimates of *undeveloped* oil and gas reserves, the SEC has relaxed their prohibition for oil and gas resources for 2010 onwards, citing improvements in estimation technology. As stated previously, the prohibition remains in force for hard

[74] The distinction between developed and undeveloped oil and gas reserves is a rough proxy for commercial viability, *i.e.*, the distinction between hard rock ore reserves and contingent resources.

rock resources. This prohibition creates a disadvantage for (a) explorers that have not yet thoroughly assessed the commercial viability of their deposits, and, (b) developers and producers that contain large quantities of commercially marginal resources.

> *H_{1b}: Estimates of contingent resources and estimate of inferred resources are positively associated with firm market value.*

The utility of estimates of contingent resources relates to their ability to provide insights into future revisions of resources into reserves. Therefore, these estimates are economically credible when relating to deposits with i) marginal resources (resource grade demonstrates potential economic viability, *i.e.* an attractive contribution margin per unit) and ii) either a) immediately adjacent to reserves (expansion of an existing extraction zone), or b) large enough to justify a new extraction zone (low incremental fixed cost per unit). If the combination of assessed contribution margin and incremental fixed cost is not likely to justify potential economic viability, estimates of contingent resources will lack credibility. Under the professional reporting codes, it is the responsibility of the estimate issuer (management or expert) to delineate contingent resources in an informative manner (by project, deposit, and zone in order to ascertain how much is economically marginal, how much is adjacent to reserves, and how much is large).

The utility of estimates of inferred resources primarily relates to their ability to provide insights into future revision into developed resources. Estimates of inferred resources are geologically credible when persuasively “inferred from geological evidence and assumed … geological and/or grade continuity” (JORC Code §20). Procedurally, it is the responsibility of the estimate issuer to ascertain whether there is sufficient geological evidence and continuity to justify an inferred resource estimate. To increase the persuasiveness of inferred estimates, it is common practice to disclose individual drill results prior to, and even concurrent with, inferred estimates in the early stages of evaluation.

The credibility of resource estimates is also influenced by the signalling effects surrounding the disclosure of the estimates. Reputational capital considerations play a major role in the disclosure and interpretation of resource estimates. Managers with high reputational capital assumedly enjoy relatively lower cost of capital, while managers with low reputational capital (and high cost of capital) are exposed to the disciplinary effects of the market for corporate control of Manne (1965). Ferguson *et al*. (2013) and Pundrich *et al*. (2013) also examine the ability of management to hire external experts (with their own reputational capital) to estimate the resources or provide related assurance services. Similarly independent directors, as monitors of management, can act as substitutes for assurance, as well as overseeing the business decisions that occur prior to disclosure (Anderson *et al.*, 1993).

Managerial shareholding can also be a positive signal because, as management owns a larger portion of the company, management interests are bonded to shareholders' (Jensen & Meckling, 1976). However, problems can occur from managerial shareholding. Excessive managerial shareholding can entrench management, subverting the disciplinary effects of the market for corporate control (Manne, 1965), and creating large shareholder costs (Morck *et al.*, 1988).

3.4 The determinants of revisions of resource estimates

3.4.1 The determinants of revisions of contingent resource estimates into reserves

Prior to June 2008, SEC filers included estimates of inferred and contingent resources as mineralised material. After informal guidance by the SEC in June 2008, SEC filers removed inferred resources from mineralised material. The impact of both (a) the lack of decomposition between contingent and inferred, and (b) the prohibition against including inferred estimates in mineralised material (and therefore being disclosed in SEC-filings), is influenced by differences between the inferred and contingent categories. A key difference between estimates of contingent and inferred resources is the different determinants of their conversion into reserve estimates. These differences naturally translate into differences in the intrinsic value of these estimates.

The resource reporting framework requires improvements in the commercial viability of the estimates of contingent resources in order to be reclassified into estimates of reserves.[75] Assuming the gold price increases over the long-term, *i.e.* is not mean reverting, at a rate greater than extraction costs, the ability of current estimates of contingent resources to predict future estimates of reserves is conditional upon future increases in the gold price. Conversely, future decreases in the gold price can result in reserves losing commercial viability and being reclassified as contingent resources.

Alciatore (1993) reports evidence that changes to oil and gas reserve estimates are not value relevant (when examining cumulative abnormal returns) on their own, but are price-sensitive when interacted with oil price movements. Blose and Shieh (1995) develop and test a model for examining the elasticity of the stock return of gold firms to movement in the gold price ('gold beta'). Tufano (1998) extends Blose and Shieh (1995) by examining more determinants of cross-sectional variation in gold betas. None of these studies examine the effect of gold price movement on the reclassification of estimates of contingent resources into ore reserves or the value relevance of estimates of contingent resources.

> H_{2a}: *The association between estimates of contingent resources and future change in estimates of reserves is conditional upon future increases in the gold price.*[76]

If the ability of current estimates of contingent resources to predict future estimates of reserves is conditional upon future increases in the gold price, the price-sensitivity of estimates of contingent resources is conditional upon the extent to which

[75] The commercial viability X-axis in the JORC Code diagram (reproduced as Figure 2 on page 110) refers not only to economic viability, but also to other 'modifying factors,' including "legal, environmental social and governmental factors." Changes in these factors can also affect the distinction between estimates of contingent resources and ore reserves.

[76] I provide a graphical representation of H_{2a} in Figure 4b.

lagged gold price movement, increases or decreases, can proxy for future increases in the gold price.

> *H_{2b}: The association between estimates of contingent resources and firm market value is conditional upon lagged movement in the gold price.*

3.4.2 The determinants of revisions of inferred resource estimates into developed resources

The resource reporting framework requires improvements in the geotechnical certainty of the estimates of inferred resources in order to be reclassified into estimates of developed resources, *i.e.*, improvements in the number and spacing of drilling data points. Exploration (and evaluation, and definition) expenditure is spent on improving geotechnical certainty and revising estimates. The ability of estimates of inferred resources to predict future estimates of developed resources is therefore conditional upon future exploration (and evaluation, and definition) activity.

> *H_{3a}: The association between estimates of inferred resources and future change in estimates of developed resources is conditional upon future exploration expenditure.*[77]

If the ability of current estimates of inferred resources to predict future estimates of developed resources is conditional upon future exploration expenditure, the price-sensitivity of estimates of inferred resources is conditional upon the extent to which the previous year's exploration expenditure can proxy for future expenditure. Given the principle of diminishing marginal returns, the results from exploration expenditure are likely to decrease over time as firms explore what are expected to be progressively lower quality areas. Spear (1994) examines the association between abnormal share returns and the unexpected change in exploration, production, acquisition and revision, and reports evidence that only the unexpected exploration was significant.

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[77] I provide a graphical representation of H_{3a} in Figure 4c.

H_{3b}: The association between estimates of inferred resources and firm market value is conditional upon the amount of exploration expenditure in the last year.

3.4.3 The determinants of revisions of inferred resource estimates into reserves

Recall that developed resources are the sum of reserves and contingent resources. After sufficient exploration activity has justified the reclassification of inferred resources as developed resources, the question remains: 'how much of the reclassified inferred resources will become reserves and how much will become contingent resources?' Based on the exploration results, inferred resources that turn out to be commercially viable will be reclassified as reserves, while those that turn out to be commercially unviable will be classified as contingent resources. While the direct cause of the reclassification is exploration activity, the moderating effect in this reclassification is commercial viability.

Unfortunately, the commercial viability of inferred resources is not reliably known prior to the exploration results that confirm or deny that viability. However, the commercial viability of the developed resources is known *ex ante*. On the one hand, the commercial viability of the inferred resources is likely to be less than the commercial viability of the existing developed resources because profit-maximising / risk-minimising mining firms presumably focus on developing the best resources first. On the other hand, the commercial viability of the inferred resources could be more than the existing developed resources because the current commercial viability of the developed resources has a downward bias, relative to the pre-production level of commercial viability, due to the annual extraction of reserves. In other words, as production removes minerals from both the reserve and developed resource estimates, the proportion of the former to the latter declines (if contingent resources are greater than zero). If the commercial viability of the existing developed resources is a good proxy for the commercial viability of the reclassified inferred resources, then the ability of estimates of inferred resources to predict future estimates of reserves is conditional upon (a) future exploration activity, and (b) the current commercial viability of developed resources.

H_{4a}: The association between current estimates of inferred resources and future change in estimates of reserves is conditional upon the current proportion of developed resources that are reserves.[78]

H_{4b}: The association between estimates of inferred resources and firm market value is conditional upon the proportion of developed resources that are reserves.

4.0 Data and Research Design

4.1 Sample and data sources

I follow Brown *et. al.* (2007) by focusing upon the gold extraction sub-industry,[79] due to its relatively homogeneous nature.[80] I include gold mining companies that are applying the Canadian, Australian, or USA resource classification codes, and listed on the stock exchanges of one or more of those countries.[81] Due to the time-consuming task of hand collecting the resource data, the firms I include constitute those with domestic exchange tickers between the letters A and D inclusive. Table 9A outlines the sample selection process. Out of 19,945 gold firm-years (2,187 gold firms) during 1995-2008 inclusive, 4,816 firm-years (528 firms) have tickers between A-D, roughly one quarter. Explorers without resource estimates constitute the clear majority at 2,995 firm-years. I do not include these explorers in this study as I am examining resource estimates. I also do not include a further 1,113 explorers disclosing resources but not reserves, because focusing on producers[82] and developers[83] facilitates a homogenous sample.[84] In addition,

[78] I provide a graphical representation of H_{4a} in Figure 4d.
[79] GICS code 15104030 (Gold); NAICS codes 21222 (Gold Ore and Silver Ore Mining) and 212221 (Gold Ore Mining); SIC code 1041 (Gold Ores).
[80] After extraction, gold ore is smelted on-site or nearby, to a standardised level of purity.
[81] ASX, Amex, NASDAQ, NYSE, TSX or TSXV.
[82] Firms reporting yearly sales revenue from extraction activities.

there are 51 firm-years which are non-disclosing producers, around 7%.[85] This leaves a sample of 657 firm-years (118 firms) with disclosed estimates of gold reserves.

Producers and developers regularly revise their resource estimates, at least annually, and disclose historical results or forecasts that are used by investors in their valuation of those firms. As opposed to producers and developers, the exploration activities of explorers are higher risk. As such, explorers' resource estimate revisions presumably are less frequent, have greater dispersion and year-to-year variation, and therefore may not be appropriate for short or medium-term analysis. In the case of the USA, explorers are typically cross-listed firms that have utilised the exemption to the SEC restriction. Cross-listing on the TSX(V) provides USA-based explorers with an opportunity to disclose a breakdown of their resource estimates.

Table 9B reports the univariate results from comparing the USD market capitalisation of all mining firms (not just gold) with tickers A-D and E-Z within Australia and North America.[86] In Australia, the 1,647 (or 31%) A-D firm-years have a significantly higher mean than the 3,691 E-Z (984m to 370m, *t*-stat = 2.737, *p*-value = 0.006). The significant result for the parametric test will be influenced by the distribution of all mining firms being skewed by a large number of small firms / small number of large firms. In a non-parametric test, the A-D firm-years have an insignificantly different median (10.8m to 11.4m, *p*-value = 0.573). The statistical significance in both tests is boosted by the inclusion of multiple firm-year observations for the same firm. This boost can bias the result if large firms are more likely to survive across years than small firms. When I analyse the firm means across the years, there is no longer a significant difference

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[83] Pre-revenue firms that have reported Ore Reserves.

[84] Poskitt (2005) and Brown *et al*. (2007) emphasise the critical differences between producers and explorers in the context of operations and valuation. Brennan and Schwartz (1985), Paddock *et al.* (1988), and Colwell *et al.* (2002) suggest the valuation of exploration firms is based on a nested real options model that is far more complicated and subjective than valuing producers and explorers.

[85] Mirza and Zimmer (2001) examine the reasons why producers might choose not to publically disclose reserve estimates. I discuss some motivations above in Section 3.2 'resource disclosure as voluntary disclosure.'

[86] I do not separate SEC filers from NI 43-101 filers because a) the SEC restriction has motivated many USA-based mining firms to re-domicile to Canada, and, related to this, b) the TSX markets itself as the premier mining capital market in the world.

in the mean (234 [30%] A-D firms at 603m to 538 E-Z firms at 262m, *t*-stat = 1.061, *p*-value = 0.290) or the median (17.2m to 17.8m, *p*-value = 0.894). Even though the mean A-D market capitalisation mean across years is more than twice that of E-Z, the parametric test is insignificant and the medians are similar (within 1m), which is consistent with a large number of small firms / small number of large firms.

In North America, the 1,486 A-D (or 28%) firm-years have a significantly smaller mean (104m to 310m, *t*-stat = 6.511, *p*-value < 0.001), and a significantly lower median (13m to 15m, *p*-value = 0.018), compared to 3,836 E-Z firm-years. The North American firm means across the years provide similar results: a significantly smaller mean (330 [27%] A-D firms at 73m to 888 E-Z firms at 188.5m, *t*-stat = 3.075, *p*-value = 0.002), but an insignificantly different median (13.9m to 13.4m, *p*-value = 0.486).[87] Although the North American sample appears to contrast with the Australian vis-à-vis the relative market capitalisation of A-D compared to E-Z, both distributions are consistent with the effect of a large number of short-lived small firms and a small number of long-lived large firms, where the small number of long-lived large firms are randomly allocated across A-D and E-Z. This analysis suggests that there is not a systematic bias within the A-D sub-sample compared to the rest of the market.

To examine the association between estimates of resources and firm market value, I require data on both. Due to missing share price data,[88] I remove 87 firm-years from the valuation analysis. I also remove 195 firm-years from the valuation analysis for being atypical gold production/developer firms (less than 100,000 ounces of reserves or less than 33% of reserve value is gold). These exclusions are similar to, and highly correlated with, Ferguson *et al.* (2011) excluding firms with less than 60% of reserve value is gold, and Grundy and Heaney (2012) excluding firms with the top/bottom 2.5% of (firm)value-to-(gold)reserves ratio.

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[87] An attentive reader may notice that the numbers of total mining firms/firm-years in Table 9B are similar to the numbers for gold mining in Table 9A, despite gold mining being a sub-set of total mining. Observations in Table 9B require market capitalisation data, whereas those in Table 9A do not require such.

[88] Missing pricing data is due to either missing data from feasibility report (62 firm-years) or delisting (25 firm-years).

A breakdown of the sample is provided in Table 10. Of the 657 firm-year observations reporting reserve estimates, 313 report under the Canadian CIM Definition Standards / NI 43-101, including thirty firm-years headquartered in the USA but listed in Canada, 272 report under the Australasian JORC Code, and 72 firm-years report under SEC Industry Guide 7. Breakdown by year reveals a relatively consistent number of firm-years over time, although the Canadian sub-sample is artificially small in 1995 as I could not access these disclosures. While most years include roughly fifty unique firms, overall trends illustrate a decrease in the number of JORC and SEC firms, with a growing number in CIM / NI 43-101 firms, consistent with the views of Brown *et al.* (2007). The number of Canadian firms has grown since the reporting system changed from the previous NPS 2-A to NI 43-101 effective February 2001. Of the thirteen firms reporting under SEC Industry Guide 7 in my sample, three were taken over by other USA firms, six were taken over by Canadian firms, two cross-listed on the TSX(V) and thereby switched to reporting under NI 43-101, and two were still reporting under SEC Industry Guide 7 in 2008, meaning the majority (eight of thirteen, or 61.5%) of the SEC firms effectively switched to NI 43-101 during my sample period.

Firm-level resource and extraction data is hand collected from annual reports, technical reports and feasibility reports. Canadian reports were obtained from the SEDAR website. Australian reports were obtained from Aspect Huntley DatAnalysis website. USA reports were obtained from the EDGAR website. North American trading data is obtained from Thompson’s Datastream. North American accounting data is obtained from Compustat and financial reports. Australian trading data is obtained from SPPR. Australian accounting data is obtained from the Aspect Huntley FinAnalysis database.

SEC annual reports and NI 43-101 technical reports follow a specific template, which makes the identification of resource estimates easier. While Australian firms are not required to follow a set template, reserve and resource estimates are typically easily identified from annual reports, given the incentives for firms to disclose these estimates in a clear manner. Some of the small firms, however, appear to lack sufficient investment in the quality of their supplementary information in their annual reports, and so their estimates are either buried in text or not reported at all (Craswell and Taylor, 1992). What was often not clear was the comparison of estimates, which is central to my thesis. This was especially the case when, at different times, adjacent projects were combined or a project was split into components. Detailed longitudinal reconciliations were rare.

All three reporting codes place a strict emphasis on properly labelling the different types of estimates (*e.g.* 'reserves', 'resources', and 'non-compliant'). It is an objective of the reporting codes to eliminate as much interpretation subjectivity as possible. What was problematic was the distinction between resources exclusive/inclusive of reserves, as this is important when examining contingent resources (as emphasised in the JORC code). Once again, longitudinal analysis could be subjective when there was a change in the assumptions underlying the estimates (should I hold the assumptions constant, or allow the assumptions to change as the economic environment changes?), although choice was not always possible (while NI 43-101 firms are required to disclose sensitivity tests, SEC and JORC firms are only encouraged).

4.2 Variable measurement

To re-cap, as exploration of a mineral deposit progresses, the geological confidence of the resource estimates increase, and the estimates are categorised accordingly. Inferred resources are the most preliminary category, and progress into developed resources. From developed resources, ore reserve estimates are identified as the commercially viable portion, while contingent resources are the unviable portion. Over time, ore reserves are extracted, processed into a marketable commodity, such as gold bars, and sold.

Hypotheses H_{1a}, H_{2a}, H_{3a} and H_{4a} relate to future revisions to resource estimates, and as such will require a control variable for project acquisition/disposal. H_{1b}, H_{2b}, H_{3b} and H_{4b} relate to market value, and as such will require price-related control variables (*e.g.* book value, and non-gold resource estimates). Hypotheses H_{2a} and H_{2b} relate to gold price movements, while H_{3a} and H_{3b} relate to exploration expenditure.

Estimates of future reserves or developed resources include any cumulative production over the period, divided by the recovery rate, as this number reflects the ounces in estimates of reserves or resources that were extracted independently of the operational efficiency of ore processing. Firm value is measured six months after the financial year end date for two reasons; i) to allow time for the micro firms to release their annual report, and ii) to allow time for a market reaction to these reports for the thinly traded firms.[89] Subsequent gold price movement is measured based on the financial year end date to match the resource estimate dates. Lagged gold price movement is measured based on six months after the financial year end date to match the firm value dates.

Variables are based on disclosed estimates for a given year, in ounces scaled by the number of ordinary shares on issue at the end of year 't'.[90] For producing deposits, these estimates need to be interpreted in conjunction with extraction figures. As extraction figures are expressed in relation to the financial accounting period, mineral resources are estimated as at financial year end. Similar to figures reported in the financial statements, the mineral resource estimates relating to the financial year end are not disclosed until the annual report is released months later. For pre-production deposits, mineral resource estimates are not affected by production, and are estimated as at the date of the technical report, which can potentially be disclosed to the capital market on the same day. To facilitate the comparison of contemporaneous estimates of producing and pre-production deposits, my study incorporates mineral resource estimates for producing deposits as at financial year end, and estimates for pre-production deposits as at six months after the financial year end, also corresponding to the date of market value. All dollar values are expressed in USD.

[89] I include a sensitivity test for values measured three months after year end in section 5.5.3. "Utilising the market price from three months after the financial year end."
[90] Barth and Clinch (2009) recommend the use of number of ordinary shares on issue as a scaling variable in value-based regressions as it performs the best in simulations of scaling issues.

I utilise firm-level variables as opposed to project level. To the extent that firms can own, acquire and dispose of, different types of projects that are unrelated,[91] firm-level analysis can bias against finding a result. On the other hand, firm-level analysis can exacerbate the project-level survivorship bias as firms acquire good projects and dispose of bad projects. Firm-level analysis is necessary for the price-sensitivity tests, as well as the tests relating to exploration expenditure, because these variables are available only at the firm-level. Although firms can buy and sell projects, most investors can only buy and sell firms' shares. Even at the project-level, projects can expand and contract in scope, adding and subtracting deposits and mineral formations. Perhaps the ideal variables would be calculated at the finest level possible and limited to a sample of exhausted entities, *i.e.* entities that have disclosed estimates at one date and ceased exploration/development/production at a later date, thereby removing the need for estimates on the left-hand side (LHS) and minimising the effect of survivorship bias. Variables calculated at the finest level possible would also maximise the size of the sample because one firm can own many projects.

Following figure 3, estimates of total resources (*Resc*) can be decomposed into the commercially-viable portion (reserves, *Resv*), the commercially-unviable portion (contingent resources, *Con*), and the commercially unverifiable portion (inferred resources, *Inf*).[92] Estimates of mineralised material (*MinMat*) constitute *Con* plus *Inf* (*i.e.*, not *Resv*).[93] Estimates of developed resources (*Dev*) constitute *Resv* plus *Con* (*i.e.*, not *Inf*).[94] Byproduct, '*Bypr*,' includes all non-gold commodities sold as byproducts of the gold production process, estimated at the total resource level. *SResv*, *SCon*, *SInf* and

[91] For example a firm owning just one producing project with expansion opportunities is quite different to a firm owning both a producing project without expansion opportunities and an unrelated non-producing project with expansion opportunities.

[92] $Resc = Resv + Con + Inf$

[93] $Resc = Resv + MinMat$, and $MinMat = Con + Inf$

[94] $Resc = Dev + Inf$, and $Dev = Resv + Con$

SBypr are the corresponding estimates multiplied by the spot price in USD as at six months after the balance date.[95]

'*MVE*' is the stock price six months after the financial year end. '*GoldMove*' is the percentage movement in the gold price from six months after the balance date to 'T' years ahead, corresponding to the date of *MVE*, or from -T years behind to the balance date, corresponding to the date of resource estimates. *GoldMove* is also partitioned piece-wise into positive and negative values, *PosGold* and *NegGold* respectively. '*Expl*' is the ratio of exploration expenditure to reserve value, comprising the cumulative sum of future expenditure on exploration over 'T' years (USD, deflated by current *SResv*). I use the cash-based measure of exploration expenditure as different firms apply different accounting standards.[96] '*Acq*' is the percentage future change in the number of projects disclosing *Resc* over 'T' years.[97] '*Prod*' is the rate of production, comprising production ounces deflated by the sum of production and reserve ounces. '*Sunk*' is the book value of property, plant and equipment, and intangible assets, including mining exploration, development and rehabilitation. I label capitalised fixed costs as sunk costs in the sense that these are once-off costs required to develop the project into production or, in the case of rehabilitation, required to finalise the project after production.[98] '*CapEx*' is the expected future expenditure on *Sunk*, estimated in the feasibility report. '*BVEa*' is the book value of ordinary equity minus *Sunk* and *CapEx*.[99]

Descriptive statistics for the variables are reported in Table 11. The decrease in observations from the original 657 (T=0) to 77 (T=10) is due to both (i) firms dropping

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[95] In the case of by-products, the relevant spot price will correspond to the non-gold commodities. Therefore, *SBpyr* is the dollar value sum of the quantity of each non-gold commodity (*e.g.* silver, nickel, copper) multiplied by its respective spot price.

[96] See Section 2.2 'Financial reporting'

[97] If all projects are a constant size (*i.e.*, reclassification is zero), then total reserves equals total projects multiplied by that size constant (Total = Number * Mean), the percentage change in total reserves equals the percentage change in total projects (%ΔTotal = %ΔNumber), and the change per share in total reserves equals the change in total projects multiplied by the size constant (ΔTotal = ΔNumber * Mean). If all projects are not a constant size (as is reality, and necessary for H_{1a}, H_{2a}, H_{3a} and H_{4a}), then noise is introduced into the model through acquisition/disposal. As long as the noise is not systematic relative to resource disclosure (*e.g.* acquiring mostly developed projects) it is not an issue for testing the hypotheses.

[98] A different use of the term 'sunk cost,' which I do not apply in my thesis, refers unavoidable costs that do not provide future benefits.

[99] I discuss these adjustments in section 2.2.3. 'Implications of financial reporting methods.'

out of the sample due to survivorship issues, as can be seen in the decline in observations in Table 10 for JORC and SEC firms, and (ii) the limited sample period of 1995-2008.[100] The first cause creates a survivorship bias (which I discuss in Section 4.4.3), although it should be noted that most mining firms that drop out of the sample are successful smaller firms acquired by larger firms, resulting in a large firm bias. The second cause limits the generalisability of the results as the long-term analysis is limited to the earlier years, which may not be representative of a full gold price cycle.

The bottom panel of Table 11B highlights the different available sub-samples associated with data availability. As shown in Table 9A, the full sample of firms reporting reserves includes 657 observations. As shown in Table 10, 585 of the 657 observations are not subject to SEC Industry Guide 7, and therefore report estimates of contingent and inferred resources, although only 544 actually do report these. Roughly one third of firm-years are developers, with 462 observations being engaged in production. As also shown in Table 10, 375 of the 657 observations have pricing data, or 321 of the 585 observations not subject to SEC Industry Guide 7.

The bottom panel of Table 11B shows the dollar value of resource estimates (ounces * gold price) is, on average, several times larger than the dollar value of the balance sheet items, and highlights the importance of *in situ* resource ounces for the value of gold mining firms. Roughly 40% of estimated resource ounces are reserves, which means the majority of firms' resource ounces are 'mineralised material' subject to the restriction in SEC Industry Guide 7. The proportion of mineralised material that is inferred resources ranges from none to all and highlights the cross-sectional variation that is lost when firms are subject to SEC Industry Guide 7.

The wide range in each variable, *e.g.* resource estimates vary from a minimum of less than 0.001 ounces, or $0.25, to a maximum of more than 7.6 ounces per share, or $2,300, is in part determined by the range in the scaling variable, namely the number of

[100] Year 2008 observations are not represented in T=1 onwards as I have no data after 2008, 2007 observations are represented in T=1, but not T=2 onwards, 2006 observations are represented in T=1 and T=2, but not T=3 onwards, *etc*.

issued shares. The market value of these shares similarly ranges from less than $0.01 to more than $75 per share, in part due to differences in the number of issued shares. Firms that do not have a history of realised profits are typically funded by issuing shares, while firms with a history of realised profits are typically funded either through retained profits or issuing debt. On average, Australian firms tend to have roughly ten times the number of issued shares of Canadian firms, which in turn have ten times the issued shares of USA firms. This country-level effect is partly due to the larger proportion of firms with a history of realised profits in the USA (more DSEs in Canada and Australia), as well as the relative acceptance of firms with a share price less than $1 in Australia relative to North America, where share consolidation is more common.

A correlation matrix of the right hand side (RHS) variables is reported in Table 12. In Table 12A, there is a clear positive correlation between most variables, for a number of reasons. First, all the variables are scaled by the number of shares outstanding, which increases the correlation. Second, the resource estimate variables are all multiplied by the spot price, which increases the correlation. Third, high correlation is typical of additive disaggregation (as opposed to multiplicative disaggregation) studies, which increases the correlation between the resource estimate variables and between the accounting variables. Table 12B reports the correlation between exploration expenditure in year ‘t’ and exploration expenditure over the following ‘T’ years. Once again, there is a clear positive correlation due to scale effects, but the correlation also suggests that current exploration expenditure may be a good indication of future exploration expenditure. The correlation is also increased by the positive feedback mechanism between exploration expenditure and exploration success, which is magnified by the survivorship bias.

A graphical representation of the movement in the gold price over the period 1985 to 2009 is provided in Figure 5. Two distinct periods can be seen: (i) for the first twenty years (1985 to 2005) the gold price roughly follows two-and-a-half eight-year cycles with a floor of $300, a ceiling of $400 and an overall downward movement, and, (ii) from 2005 onwards, the historical upper bound is clearly broken as the gold price grows at roughly 20% *p.a*. During the first period, which exhibits a gold price decline, estimates of contingent resources are unlikely to be converted into reserves as there is insufficient sustained growth in the gold price. However, during the second period which exhibits an increasing gold price, a portion of the estimates of contingent resources are very likely to be converted into reserves as there is clearly sustained growth in the gold price. As historical gold price movement is only a good indication of future gold price movement within each period, the shift between these two clearly distinct periods limits the generalisability of the results since the long-term analysis compares estimates made during the earlier cyclical period to estimate revisions made during the later rising gold price.

To maximise the sample size, the regressions are based on panel data that exhibits cross-sectional and serial correlation. Estimates of reserves are serially correlated by construction, because estimates at different points in time relate to the same project(s) which do not fundamentally change year-by-year. Year-by-year changes in the estimates of reserves are cross-sectionally correlated due to the effect of common movements in the gold price. To minimise the impact of cross-sectional and serial correlation on the regression co-efficients, the regressions can include adjustments for period and cross-sectional fixed effects and are all utilise White's diagonally corrected errors. Regressions with *MVE* on the LHS, but without *GoldMove* on the RHS, include adjustments for both period and cross-sectional fixed effects. However regressions with *MVE* on the LHS and *GoldMove* on the RHS only include adjustments for cross-sectional fixed effects because *GoldMove* is cross-sectionally identical. Regressions with a reserve or resource estimate on the LHS, but without *GoldMove* on the RHS, only include adjustments for period fixed effects because reserve/resource estimates are serially correlated. However regressions with a reserve or resource estimate on the LHS and *GoldMove* on the RHS do not include any such adjustments, for the above reasons.

4.3 Empirical modelling

4.3.1 The components of estimates of total resources

4.3.1.1 Predicting future changes in reserve estimates

Prior research examining the reliability of estimates of reserves, principally relating to oil and gas firms, has examined the magnitude, direction, variance and determinants in the revision of reserves (e.g. Spear and Lee, 1999). To analyse the difference in predictive ability between estimates of reserves *Resv*, which the SEC requires, and estimates of mineralised material, *MinMat*, which the SEC restricts, I regress the change in estimates of reserves after T years ($Resv_{t+T} - Resv_t$) on $Resv_t$ and *MinMat*, controlling for project acquisitions after T years (Acq_{t+T}), as in Equation (1):

$$Resv_{i,t+T} - Resv_{i,t} = \beta_0 + \beta_1 Resv_{i,t} + \beta_2 MinMat_{i,t} + \beta_3 Acq_{i,t+T} + \beta_4 Acq_{i,t+T} * Resv_{i,t} + \varepsilon_{i,t+T} \quad (1)$$

I conduct a *t*-test to test whether the predictive ability of *MinMat* (β_2) is significantly greater than zero. An insignificant β_2 would be consistent with SEC Industry Guide 7 in restricting the disclosure of estimates of resources that are not reserves. A significant β_2 would be consistent with the professional mining community's position that even estimates of resources that are not reserves can be informative. I conduct an *F*-test to test whether the predictive ability of *Resv* (β_1) is significantly greater than β_2.

The prior literature on estimate revisions has focused exclusively on annual revisions, due to the disclosure required by SFAS 69.[101] I run my regressions with different time lags (T) up to and including ten years. By varying the time lag, my tests can accommodate differences in a short-term and a long-term focus, because tests with relatively short time lags will be biased against finding a positive result. Short-term focus

[101] Statement of Financial Accounting Standard 69 "Disclosures about Oil and Gas Producing Activities."

tests are more likely to confirm the SEC's position that mineralised material is not informative. Long-term focus tests are more likely to find a significant association for other categories in addition to reserves, and thereby support the broader practice of reporting these categories.

To test H_{1a}, differences in the predictive ability of estimates of contingent and inferred resources, I regress $Resv_{t+T} - Resv_t$ on $Resv_t$, estimates of contingent resources (*Con*) and inferred resources (*Inf*), as in Equation (2):

$$Resv_{i,t+T} - Resv_{i,t} = \beta_0 + \beta_1 Resv_{i,t} + \beta_2 Con_{i,t} + \beta_3 Inf_{i,t} + \beta_4 Acq_{i,t+T} + \beta_5 Acq_{i,t+T} * Resv_{i,t} + \varepsilon_{i,t+T} \quad (2)$$

I conduct *t*-tests to test whether the predictive ability of *Con* (β_2) and *Inf* (β_3) are significantly greater than zero. Insignificant β_2 and β_3 would be consistent with SEC Industry Guide 7 in prohibiting the distinction between categories of estimates of resources that are not reserves. I conduct an *F*-test to test whether the predictive ability of β_2 is significantly different to β_3. A significantly different β_2 and β_3 would be consistent with the professional mining community's position that estimates of contingent resources and estimates of inferred resources are informative in different ways and should be distinguished.

4.3.1.2 Price-sensitivity

Prior oil and gas research has considered the price-sensitivity of estimates of probable/possible reserves and undeveloped reserves (e.g. Clinch and Magliolo, 1992; Donker *et al.*, 2006). To analyse the difference in price-sensitivity between *Resv* and *MinMat*, I regress the market value of equity (*MVE*) on the estimates multiplied by the spot price (*SResv* and *SMinMat* respectively), controlling for mineral byproducts (*SBypr*), adjusted book value of equity (*BVEa*), sunk costs (*Sunk*), and expected capital expenditure (*CapEx*), as in Equation (3):

$$MVE_{i,t} = \beta_0 + \beta_1 SResv_{i,t} + \beta_2 SMinMat_{i,t} + \beta_3 SBypr_{i,t} + \beta_4 BVEa_{i,t} + \beta_5 Sunk_{i,t} + \beta_6 CapEx_{i,t} + \varepsilon_{i,t} \quad (3)$$

Following Miller and Upton (1985), the co-efficient for *SResv* (β_1) is predicted to be equal to the net cash profit margin on sales of gold. Adelman (1990) implies that a typical gross cash profit margin on sales for an oil and gas firm is 67%, but for the gold firms in my sample, the average net cash profit (EBITDA) margin on sales is 26%. The co-efficient for *SMinMat* may be insignificantly different to zero, suggesting the estimates are not price-sensitive, due to low accuracy or low reliability, consistent with the SEC's position, or significantly greater than zero, suggesting the estimates are price-sensitive, consistent with the professional mining community's position. The co-efficient for *SBypr* (β_3) is predicted to be one because the cost of producing the byproducts is included in the cost of producing the gold. Following Miller and Upton (1985) and related studies, the co-efficient for *BVEa* (β_4) is predicted to be one because the book value of these net assets is assumed to equal the market value. I follow Boone (2002), not Miller and Upton (1985), by including *BVEa* on the RHS (not the LHS) so as not to restrict its co-efficient to one.[102] Following Magliolo (1986), the co-efficient on *Sunk* (β_5) is predicted to be the marginal income tax rate because historical sunk costs can used for tax deductions. Similarly, the co-efficient on *CapEx* (β_6) is predicted to be the marginal income tax rate because future capital expenditure will become sunk costs.

To test H_{1b}, I regress *MVE* on *SResv*, *SCon* and *SInf*, as in Equation (4):

$$MVE_{i,t} = \beta_0 + \beta_1 SResv_{i,t} + \beta_2 SCon_{i,t} + \beta_3 SInf_{i,t} + \beta_4 SBypr_{i,t} + \beta_5 BVEa_{i,t} + \beta_6 Sunk_{i,t} + \beta_7 CapEx_{i,t} + \varepsilon_{i,t} \quad (4)$$

In recent years, the price-sensitivity literature has often based their valuation analysis on Ohlson (1995). The original Ohlson (1995) model extended the Edwards and Bell (1961) model by including "linear information dynamics" to simplify the estimation

[102] Boone (2002) includes *BVEa* on the LHS as the LHS variable of interest is the book value of reserves. Although none of my variables of interest are book values, I nonetheless include *BVEa* on the LHS so as to properly assess the incremental information of my variables of interest.

of future residual income.[103] One important insight in Ohlson (1995) is that when the market forecasts future residual income, in addition to analysing present and past residual income, they include 'other information' that is a leading indicator of future residual income. For example, when a firm announces the commencement of a new project, the residual income expected from that project will be reflected in forecasts of future residual income, but not past residual income. A typical 'Ohlson-style' research model involves regressing market value of equity on book value, net income and some proxy(s) for other information.[104]

Several academic studies examine the price-sensitivity of certain items of other information. Some studies consider industry heuristics, widely used as key performance indicators within the industry, as price-sensitive other information. Examples include population coverage and market penetration for the mobile phone industry (Amir and Lev, 1996) or load factor and available ton miles for the airline industry (Behn and Riley, 1999). Some studies consider broader key performance indicators, such as customer satisfaction surveys (Ittner and Larcker, 1998) or microeconomic factors (Cheng, 2005). Cheng (2005) conceptualises microeconomic factors within the Ohlson (1995) model as determinants of the persistence of residual income rather than 'other information.'

Some studies consider industry heuristics from industries where current income provides little indication about future income because GAAP income does not persuasively match expenses with revenues. These industries provide an intuitive setting to test the price-sensitivity of other information, distinct from the persistence of residual income. DSEs are an example of firms that report GAAP losses as they progress towards a profitable future (Ferguson *et al.*, 2011a; Ferguson *et al.*, 2011b). Trueman *et al.,* (2000) and Demers and Lev (2001) look at website visitor characteristics as proxies for the future earnings potential of development-stage Internet firms. Matolcsy and Wyatt (2008) look at the characteristics of patent applications as proxies for the future earnings potential of development-stage technology firms.

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[103] See also Dechow *et al.* (1999) for methods of inferring other information from analyst forecasts..
[104] The extent to which such an approach is consistent with Ohlson (1995) is debateable.

The extractive industries offer another setting where an industry heuristic, resource characteristics, provides an indicator of future income that supplements past income.[105] Resource characteristics could be a particularly useful form of other information due to the unique combination of homogeneity and relevance to the industry. Resource characteristics are based on scientific measures of elemental compounds, providing a degree of homogeneity that facilitates objective numerical comparisons. The international markets for the homogenous products of extractive industries offer a direct link between resource characteristics and future revenues.

Brown *et al.* (2007) include estimates of total resources as a proxy for other information for gold mining producers, firms with a positive net income, and DSE explorers. I make the following changes to their model: (i) I do not include net income, (ii) I include adjustments for fixed costs, *i.e.* capitalised sunk costs and expected future capital expenditure), (iii) I partially disaggregate resource categories, and (iv) I include production credits, saleable by-product commodities. I do not include net income as a separate variable because, although the present value of residual income is a key component of the model in Ohlson (1995), he models the persistence of residual income as an infinite series dissipating into a finite sum, whereas the income that mining firms derive from their resources is limited to the quantity and quality of the resources.

I include adjustments for fixed costs for three reasons. First, the extractive industries treat capital expenditure as a sunk cost, not price-sensitive, because, once again, income is not an infinite series but limited to the quantity and quality of the resources. Second, not isolating the corresponding depreciation and amortisation income effects may bias the results because these rates are linked to accounting forecasts of future extraction via the straight-line or the units-of-production methods commonly used by the mining industry. Third, I follow Magliolo (1986) by including sunk costs as a proxy for future tax credits. I disaggregate the resource categories because the distinction

[105] Quirin *et al*. (2000), Berry and Wright (2001), Bryant (2003), Brown *et al*. (2007), Zhou *et al*. (2011)

between ore reserves and contingent resources is a primary indication of the commercial viability of the resource inventory.

Other studies test price-sensitivity by utilising a returns-based model, such as Alciatore (1993). Returns-based models, regressed on changes in the variables of interest, are often preferred as they are supposedly less susceptible to omitted uncorrelated variables because the change in the uncorrelated variables is assumed to be uncorrelated noise. Typical returns-based models resemble the Ohlson (1995) and Ohlson & Juettner-Nauroth (2005) models because returns resemble the change in market price, earnings the change in book value, and change in earnings is self-explanatory. I do not apply a returns-based approach to the mining setting. For producing mining firms, the returns-based model has the same problem as the Ohlson (1995) model, namely the need to isolate the price-sensitivity of levels and changes in reserves and resources from the overall price-sensitivity of levels and changes in earnings. For developing mining firms, the returns-based model has the same problem as the Ohlson (1995) model, namely an assumption of positive earnings that is not applicable for developers.

The value of producer and developer mining firms is primarily driven by the product of reserve ounces and profit margin per ounce (Hotelling, 1931; Miller and Upton, 1985). Over the short-term, the returns of mining firms are dominated by daily changes in the commodity price (Blose and Shieh, 1995; Baur, 2012), because large revisions to reserves are far less common, typically once a year. Isolating the price-sensitivity of revisions from the price-sensitivity of commodity price changes in a returns-based model is difficult due to the multiplicative relation between reserves and commodity prices.

4.3.2 Gold price movements

To test H_{2a}, on the role of gold price movements in the conversion of estimates of contingent resources into estimates of reserves, I follow Alciatore (1993) and regress

$Resv_{t+T}$ – $Resv_t$ on $Resv_t$, *Con* and movements in the gold price over T years ($GoldMove_{t+T}$), as in Equation (5):

$$Resv_{i,t+T} - Resv_{i,t} = \beta_0 + \beta_1 GoldMove_{i,t+T} + \beta_2 Resv_{i,t} + \beta_3 GoldMove_{i,t+T} * Resv_{i,t} + \beta_4 Con_{i,t} + \beta_5 GoldMove_{i,t+T} * Con_{i,t} + \beta_6 Acq_{i,t+T} + \beta_7 Acq_{i,t+T} * Resv_{i,t} + \varepsilon_{i,t+T} \quad (5)$$

I conduct a *t*-test to test whether the interaction between *Con* and *GoldMove* (β_5) is significantly greater than zero.

As the JORC/NI 43-101 framework suggests that (a) increases in the gold price are relevant to the conversion of contingent resources into reserves, but not decreases in the gold price, and, (b) decreases in the gold price are relevant to the conversion of reserves into contingent resources, but not increases in the gold price, I re-estimate Equation (5) with a piece-wise decomposition of $GoldMove_{t+T}$ into $PosGold_{t+T}$ and $NegGold_{t+T}$.

$$Resv_{i,t+T} - Resv_{i,t} = \beta_0 + \beta_1 PosGold_{i,t+T} + \beta_2 NegGold_{i,t+T} + \beta_3 Resv_{i,t} + \beta_4 PosGold_{i,t+T} * Resv_{i,t} + \beta_5 NegGold_{i,t+T} * Resv_{i,t} + \beta_6 Con_{i,t} + \beta_7 PosGold_{i,t+T} * Con_{i,t} + \beta_8 NegGold_{i,t+T} * Con_{i,t} + \beta_9 Acq_{i,t+T} + \beta_{10} Acq_{i,t+T} * Resv_{i,t} + \varepsilon_{i,t+T} \quad (6)$$

I conduct *t*-tests to test whether the interactions between: *Resv* and *PosGold* (β_4), *Resv* and *NegGold* (β_5), *Con* and *PosGold* (β_7), and *Con* and *NegGold* (β_8) are significantly greater than zero. I conduct *F*-tests to test whether β_5 is significantly greater than β_4 and β_7 is significantly greater than β_8.

To explore H_{2a} further, for estimates of inferred resources, I include *Inf* in Equation (7).

$$Resv_{i,t+T} - Resv_{i,t} = \beta_0 + \beta_1 PosGold_{i,t+T} + \beta_2 NegGold_{i,t+T} + \beta_3 Resv_{i,t} + \beta_4 PosGold_{i,t+T} * Resv_{i,t} + \beta_5 NegGold_{i,t+T} * Resv_{i,t} + \beta_6 Con_{i,t} + \beta_7 PosGold_{i,t+T} *$$

$$Con_{i,t} + \beta_8 NegGold_{i,t+T} * Con_{i,t} + \beta_9 Inf_{i,t} + \beta_{10} PosGold_{i,t+T} * Inf_{i,t} + \beta_{11} NegGold_{i,t+T} * Inf_{i,t} + \beta_{12} Acq_{i,t+T} + \beta_{13} Acq_{i,t+T} * Resv_{i,t} + \varepsilon_{i,t+T} \quad (7)$$

An alternative to *ex post* gold price movement offered by the real options modelling literature (Brennan and Schwartz, 1985) would be to include *ex ante* gold price volatility as a proxy for the likelihood of contingent resources becoming commercially viable. The categorisation of resources as either commercially viable or unviable is not explicitly linked to gold price volatility, but it might be implicitly taken into consideration when evaluating marginally viable resources. In this case, the grade (ounces per ton or grams per tonne) is a proxy for the marginal viability of contingent resources. However, the grade for contingent resources is not disclosed by Australian firms that report resources including reserves, and the JORC Code is quite clear that in this case, grade cannot be calculated without knowing the dilution factor applied.[106]

As Figure 3 illustrates, the gold price has followed two distinct periods: (i) a cycle whereby the gold price remains within a relatively fixed range (mean reverting movement), and a continued growth phase (momentum movement). To test the extent to which the use of lagged gold price movements can proxy for future gold price movements, I substitute in $PosGold_{t-T}$ and $NegGold_{t-T}$ over the prior T years, as in Equation (8):

$$Resv_{i,t+T} - Resv_{i,t} = \beta_0 + \beta_1 PosGold_{i,t-T} + \beta_2 NegGold_{i,t-T} + \beta_3 Resv_{i,t} + \beta_4 PosGold_{i,t-T} * Resv_{i,t} + \beta_5 NegGold_{i,t-T} * Resv_{i,t} + \beta_6 Con_{i,t} + \beta_7 PosGold_{i,t-T} * Con_{i,t} + \beta_8 NegGold_{i,t-T} * Con_{i,t} + \beta_9 Inf_{i,t} + \beta_{10} PosGold_{i,t-T} * Inf_{i,t} + \beta_{11} NegGold_{i,t-T} * Inf_{i,t} + \beta_{12} Acq_{i,t+T} + \beta_{13} Acq_{i,t+T} * Resv_{i,t} + \varepsilon_{i,t+T} \quad (8)$$

During a period of mean reverting movement, the $PosGold_{t-T}$ and $NegGold_{t-T}$ co-efficients are predicted to be negative, but during a period of momentum movement, the co-efficients are predicted to be positive. For the regressions where the period t+T covers the transition from mean reverting to momentum movement, the co-efficients are predicted to

[106] JORC Code (2004) §33.

be insignificantly different to zero as the use of lagged gold price movements is a poor proxy for future gold price movements.

After examining lagged gold price movements, I then test the price-sensitivity of the interaction between lagged gold price movements and estimates of reserves, contingent resources and inferred resources.

$$MVE_{i,t} = \beta_0 + \beta_1 GoldMove_{i,t-T} + \beta_2 SResv_{i,t} + \beta_3 GoldMove_{i,t-T} * SResv_{i,t} + \beta_4 SCon_{i,t} + \beta_5 GoldMove_{i,t-T} * SCon_{i,t} + \beta_6 SBypr_{i,t} + \beta_7 BVEa_{i,t} + \beta_8 Sunk_{i,t} + \beta_9 CapEx_{i,t} + \varepsilon_{i,t} \quad (9)$$

$$MVE_{i,t} = \beta_0 + \beta_1 PosGold_{i,t-T} + \beta_2 NegGold_{i,t-T} + \beta_3 SResv_{i,t} + \beta_4 PosGold_{i,t-T} * SResv_{i,t} + \beta_5 NegGold_{i,t-T} * SResv_{i,t} + \beta_6 SCon_{i,t} + \beta_7 PosGold_{i,t-T} * SCon_{i,t} + \beta_8 NegGold_{i,t-T} * SCon_{i,t} + \beta_9 SBypr_{i,t} + \beta_{10} BVEa_{i,t} + \beta_{11} Sunk_{i,t} + \beta_{12} CapEx_{i,t} + \varepsilon_{i,t} \quad (10)$$

$$MVE_{i,t} = \beta_0 + \beta_1 PosGold_{i,t-T} + \beta_2 NegGold_{i,t-T} + \beta_3 SResv_{i,t} + \beta_4 PosGold_{i,t-T} * SResv_{i,t} + \beta_5 NegGold_{i,t-T} * SResv_{i,t} + \beta_6 SCon_{i,t} + \beta_7 PosGold_{i,t-T} * SCon_{i,t} + \beta_8 NegGold_{i,t-T} * SCon_{i,t} + \beta_9 SInf_{i,t} + \beta_{10} PosGold_{i,t-T} * SInf_{i,t} + \beta_{11} NegGold_{i,t-T} * SInf_{i,t} + \beta_{12} SBypr_{i,t} + \beta_{13} BVEa_{i,t} + \beta_{14} Sunk_{i,t} + \beta_{15} CapEx_{i,t} + \varepsilon_{i,t} \quad (11)$$

4.3.3 Exploration expenditure

To test H_{3a}, on the role of exploration expenditure in the conversion of estimates of inferred resources into estimates of developed resources, I first regress the change in estimates of developed resources after T years ($Dev_{t+T} - Dev_t$) on Dev_t and Inf_t, as in Equation (12):

$$Dev_{i,t+T} - Dev_{i,t} = \beta_0 + \beta_1 Dev_{i,t} + \beta_2 Inf_{i,t} + \beta_3 Acq_{i,t+T} + \beta_4 Acq_{i,t+T} * Dev_{i,t} + \varepsilon_{i,t+T} \quad (12)$$

I then include exploration expense (*Expl*), as in Equation (13):

$$Dev_{i,t+T} - Dev_{i,t} = \beta_0 + \beta_1 Expl_{i,t+T} + \beta_2 Dev_{i,t} + \beta_3 Expl_{i,t+T} * Dev_{i,t} + \beta_4 Inf_{i,t} + \beta_5 Expl_{i,t+T} * Inf_{i,t} + \beta_6 Acq_{i,t+T} + \beta_7 Acq_{i,t+T} * Dev_{i,t} + \varepsilon_{i,t+T} \quad (13)$$

I conduct a *t*-test to test whether the interaction between *Inf* and *Expl* (β_5) is significantly greater than zero. I then decompose *Dev* into *Resv* and *Con*, as in Equation (14):

$$Resv_{i,t+T} - Resv_{i,t} = \beta_0 + \beta_1 Expl_{i,t+T} + \beta_2 Resv_{i,t} + \beta_3 Expl_{i,t+T} * Resv_{i,t} + \beta_4 Con_{i,t} + \beta_5 Expl_{i,t+T} * Con_{i,t} + \beta_6 Inf_{i,t} + \beta_7 Expl_{i,t+T} * Inf_{i,t} + \beta_8 Acq_{i,t+T} + \beta_9 Acq_{i,t+T} * Resv_{i,t} + \varepsilon_{i,t+T} \quad (14)$$

To test the extent to which current exploration can proxy for future exploration, I substitute $Expl_t$ for $Expl_{t+T}$.

$$Resv_{i,t+T} - Resv_{i,t} = \beta_0 + \beta_1 Expl_{i,t} + \beta_2 Resv_{i,t} + \beta_3 Expl_{i,t} * Resv_{i,t} + \beta_4 Con_{i,t} + \beta_5 Expl_{i,t} * Con_{i,t} + \beta_6 Inf_{i,t} + \beta_7 Expl_{i,t} * Inf_{i,t} + \beta_8 Acq_{i,t+T} + \beta_9 Acq_{i,t+T} * Resv_{i,t} + \varepsilon_{i,t+T} \quad (15)$$

4.3.4 The proportion of developed resources that are reserves

To test H_{4a}, on the role of the proportion of developed resources that are reserves in the conversion of estimates of inferred resources into reserves, I include the proportion as another interaction variable with future and current exploration expenditure separately.

$$Resv_{i,t+T} - Resv_{i,t} = \beta_0 + \beta_1 Expl_{i,t+T} + \beta_2\, Resv_{i,t}/Dev_{i,t} + \beta_3 Resv_{i,t} + \beta_4 Expl_{i,t+T} * Resv_{i,t} + \beta_5 Con_{i,t} + \beta_6 Expl_{i,t+T} * Con_{i,t} + \beta_7 Inf_{i,t} + \beta_8 Inf_{i,t} * Resv_{i,t}/Dev_{i,t} + \beta_9 Expl_{i,t+T} * Inf_{i,t} * Resv_{i,t}/Dev_{i,t} + \beta_{10} Acq_{i,t+T} + \beta_{11} Acq_{i,t+T} * Resv_{i,t} + \varepsilon_{i,t+T} \quad (16)$$

$$Resv_{i,t+T} - Resv_{i,t} = \beta_0 + \beta_1 Expl_{i,t} + \beta_2\, Resv_{i,t}/Dev_{i,t} + \beta_3 Resv_{i,t} + \beta_4 Expl_{i,t} * Resv_{i,t} + \beta_5 Con_{i,t} + \beta_6 Expl_{i,t} * Con_{i,t} + \beta_7 Inf_{i,t} + \beta_8 Inf_{i,t} * Resv_{i,t}/Dev_{i,t} + \beta_9 Expl_{i,t} * Inf_{i,t} * Resv_{i,t}/Dev_{i,t} + \beta_{10} Acq_{i,t+T} + \beta_{11} Acq_{i,t+T} * Resv_{i,t} + \varepsilon_{i,t+T} \quad (17)$$

I conduct a *t*-test to test whether the interactions between (a) *Inf* and *Resv/Dev* or (b) *Inf*, *Resv/Dev* and *Expl* are significantly greater than zero.

I then test the price-sensitivity of exploration expenditure and the interaction with the proportion of developed resources that are reserves.

$$MVE_{i,t} = \beta_0 + \beta_1 Expl_{i,t} + \beta_2 SResv_{i,t} + \beta_3 Expl_{i,t} * SResv_{i,t} + \beta_4 SCon_{i,t} + \beta_5 Expl_{i,t} * SCon_{i,t} + \beta_6 SInf_{i,t} + \beta_7 Expl_{i,t} * SInf_{i,t} + \beta_8 SBypr_{i,t} + \beta_9 BVEa_{i,t} + \beta_{10} Sunk_{i,t} + \beta_{11} CapEx_{i,t} + \varepsilon_{i,t} \quad (18)$$

$$MVE_{i,t} = \beta_0 + \beta_1 Expl_{i,t} + \beta_2\, Resv_{i,t}/Dev_{i,t} + \beta_3 SResv_{i,t} + \beta_4 Expl_{i,t} * SResv_{i,t} + \beta_5 SCon_{i,t} + \beta_6 Expl_{i,t} * SCon_{i,t} + \beta_7 SInf_{i,t} + \beta_8 SInf_{i,t} + \beta_9 SInf_{i,t} * Resv_{i,t}/Dev_{i,t} + \beta_{10} Expl_{i,t} * SInf_{i,t} * Resv_{i,t}/Dev_{i,t} + \beta_{11} SBypr_{i,t} + \beta_{12} BVEa_{i,t} + \beta_{13} Sunk_{i,t} + \beta_{14} CapEx_{i,t} + \varepsilon_{i,t} \quad (19)$$

4.4 Inferability Issues

The resource reporting code framework is based upon the distinction between low, reasonable and high confidence estimates of future outcomes. From a statistical point of view, high confidence estimates are expected to have a narrow distribution (low standard deviation) of future deviations relative to low confidence estimates. The distribution of future deviations is sensitive to the length of the time lag, such that the distribution of deviations after a long time lag will be wider (higher standard deviation) than after a short time lag.

The ability to draw inferences from the results of the statistical tests outlined in the section above is subject to the possibility of other phenomena affecting the results. These phenomena represent possible omitted correlated variables. These phenomena are associated with the inescapable reality that the exploration, development and extraction of mineral resources is a profit-seeking endeavour. The interpretation of the results in Section 5 should be made in light of the possibility of confounding effects driven by the following issues: development focus, project expansion, survivorship bias, and estimate conservatism. I also discuss differences in the definition of reserves across resource reporting codes, as well as non-linearity.

These phenomena may create, *inter alia*, three types of distortions: estimate accuracy distortions, estimate bias distortions, and temporal distortions. The oil and gas literature has examined annual revisions in estimates of reserves and concluded that estimates are 'unreliable,' because absolute revisions are significantly greater than zero, but lacking in significant bias, because signed revisions are not significantly different to zero, although most revisions are positive.[107] This literature has not examined any bias in reserve revisions over a longer time period, mostly because SFAS 69 does require reserve reconciliation over time periods longer than one year.

4.4.1 Development Focus

A simple comparison of future deviations in the estimates of low, reasonable and high confidence estimates assumes firms will develop the sections with low confidence and high confidence estimates indiscriminately. However, in reality, such a comparison may be affected by development focus, whereby firms focus their exploration and development activities on more commercially promising, higher grade sections, creating a temporary association between grade and confidence. Continued focus on the high grade section will mean that, over the short-term, high confidence sections are more

[107] King (1982), Walther and Evans (1982), Kahn *et al.* (1983), Campbell (1984), Campbell (1988), Alciatore (1990), Spear and Lee (1999).

likely to be developed than low confidence sections. If high confidence sections are being developed while low confidence sections are being ignored, deviations will be reported for the high confidence sections, based on the results of the development activity, while the estimates for the low confidence sections will remain relatively unchanged, due to the absence of corresponding development activities. Therefore, over the short-term, high confidence estimates may exhibit a counter-intuitive wider distribution (larger standard deviation) of future deviations than low confidence estimates.

In the long term, the effects of development focus may dissipate, emphasising the importance of applying long-term comparisons in my analysis. As the high grade sections are fully explored, developed and extracted, the firm's focus will move on to the medium grade sections. Low grade sections may never be fully explored, developed and extracted, because they may lack sufficient commercial potential. However, in the extreme long-term, increases in the commodity price, relative to production cost increases, will improve the commercial potential of all sections.

4.4.2 Project expansion

An extension of the development focus issue is the expansion issue, whereby the resource estimates of typically high grade deposits increase as the firm adds the typically preliminary results of a broader area. Just as low grade/confidence sections are developed after the development of high grade/confidence sections, once the originally low grade/confidence sections are developed, the firm may expand its exploration and development activities to a broader area, if commercial potential exists. The existence of large amounts of low-confidence high-grade estimates, relative to reasonable or high confidence estimates, may signal the potential for future expansion opportunities. Unlike the confounding effects of development focus, the effects of expansion will increase with the revision horizon.

4.4.3 Survivorship bias

Another extension of the development focus issue is survivorship bias, whereby sections with improving results are more likely to continue to be developed relative to sections with deteriorating results. As results from a section improve, that section is likely to attract further development, creating the opportunity for further deviation from prior estimates. As results from a section deteriorate, that section is more likely to be abandoned, ending any opportunity for further deviation from prior estimates. The statistical effect of the survivorship bias is skewness in the distribution of long-term deviations from original estimates, due to the truncating of the lower tail. This skewness will create the false impression of a positive bias in the realisation of resource estimates, *i.e.* resources are underestimated. It should also be noted that the distribution of resource deviations is naturally skewed towards the positive as resource estimates are bounded at zero. As with expansion, the effects of survivorship bias will increase with the revision horizon.

4.4.4 Estimation conservatism

A simple comparison of future deviations in low, reasonable and high confidence estimates assumes that firms will make these estimates without any systematic bias. However, in reality, such a comparison may be affected by conservatism, whereby low confidence estimates are intentionally underestimated relative to high confidence estimates. In the context of financial reporting, conservatism impacts upon the relevance/reliability balance by encouraging managers to apply a greater requirement of verification to gains than to losses (Basu, 1997), *i.e.* an asymmetric application of reliability thresholds. Watts (2003) suggests that contractual, litigation, regulatory and taxation concerns are reasons why managers are conservative in their reporting decisions. Watts (2003) refers to the criticism made against conservatism whereby negative bias (conservatism) in the current balance sheet figures will, through natural accrual methods, reverse over later periods into a positive bias in future income statements.

Lys (1986) speculates that the level of conservatism applied in resource estimates may vary across firms. The disclosers of resource reports have similar motivations and opportunities to apply conservatism in their estimation process. The Bre-X fraud and the reactionary NI 43-101 illustrate how the issues raised by Watts (2003) apply in the resource reporting setting.[108] By estimating resources conservatively, management can signal reliability to report users. Similarly, the litigation motivation of Watts (2003) applies in the resource reporting setting as report users are less likely to litigate over positive resource revisions than negative. Positive resource revisions may improve the manager's reputation for finding underestimated deposits, and thereby their remuneration.

Although resource reports are required by the JORC Code and NI 43-101 to be written by a competent person, there is no requirement for independence from management. Even when resource reports are written by an independent expert, these experts are still motivated by regulatory, litigation and reputation considerations to be conservative in estimating resources. Conservatism can be applied in the geological and statistical modelling. The categorisation of resources is based on the subjective designation of 'sufficient' data point sampling, and can reflect conservatism.

Conservatism can be applied explicitly and quantifiably to resource estimates through high cut-off grades, low top-cut grades, and even further to reserve estimates (and therefore the conversion of resources into reserves) through high dilution factors, low sale price forecasts and high production cost forecasts. The assumed gold price utilised in estimates of reserves is often emphasised by firms as being conservative (systematically lower than the current market price). Presumably, the purpose is, when assessing the current economic viability of a deposit, to allow for some degree of subsequent decrease in the gold price.

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[108] The Bre-X example also illustrates how the regulatory motivation argument from Watts (2003) is weakened when one rotten apple spoils the barrel. That is, no matter how conservative the overwhelming majority of firms may be, if one fraudulent firm causes enough damage to motivate regulatory intervention, all firms will suffer from the loss of flexibility.

Although the motivation for conservatism applies to all resource categories, arguably it applies more so to low geological confidence resources. Low confidence resources are more likely to be misleading and are examined more critically by regulators and report users. As the role of the competent person is to decide which assumptions and critical levels are applicable to the type of mineral formation examined, the competent person clearly has the opportunity, in addition to the motivation, to be conservative.

Alternatively, the motivation for conservatism arguably applies more so to high geological and economic confidence proven reserves. The resource reporting codes, especially SEC Industry Guide 7, emphasise that high confidence estimates are to be the most reliable as they are the most important estimate used in decision making. The JORC Code states that high geological confidence estimates are such that "any variation from the estimate would be unlikely to significantly affect potential economic viability." The Stillwater case, which I discuss in Section 2.3.3, is an example of the SEC requiring a larger degree of conservatism in estimating ore reserves in the form of categorisation vis-à-vis the spacing of drill holes. Given the many available avenues for introducing conservatism into resource estimates, it is possible that different methods are employed for different resource estimate categories, as well as the delineation between categories.

Conservatism has two effects: the initial negative bias, and the subsequent positive bias as the conservatism reverses (SFAC 2; Watts, 2003). As the revision horizon increases, the likelihood of low confidence conservative estimates being developed into high confidence unbiased estimates increases, and the corresponding effects of conservatism are reversed. Due to conservatism, the full development of low confidence estimates may exhibit a significant positive bias relative to high confidence estimates.

4.4.5 Differences in the definition of reserves across resource reporting codes

I have already stated that the different resource reporting codes have slightly different requirements for the designation of mineral resources as ore reserves in Sections 2.3.2 ‘The JORC Code, SME Guide and CIM Definition Standards’ and 2.3.3 ‘SEC Industry Guide 7.’ As shown in Table 8, under the JORC Code and NPS 2-A, no (pre-)feasibility report is required to justify an ore reserve estimate, a pre-feasibility report at least is required under the CIM Definition Standards /NI 43-101, and the SEC imposes relatively *ad hoc* requirements resembling a feasibility report. In my sample, 23 JORC observations (8.5%) across eight firms and 24 NPS 2-A observations (21.2%) across five firms either did not undertake a feasibility report, did not disclose the feasibility report to the market, or did not disclose an estimate of expected capital expenditure, which is required to be included in my price-sensitivity tests. Ferguson *et al*. (2013) document 18.8% of their sample of JORC-based feasibility reports had not disclosed an estimate of expected capital expenditure.

While I necessarily exclude from my price-sensitivity tests reserve estimates that are not based on a feasibility report, these estimates are still included in the reserve revision tests. While only a small proportion of the overall sample (7.0%), the effect of their inclusion in my reserve revision tests is to create a bias against finding the predicted result for estimates of contingent resources. When a firm reclassifies some of its contingent resources as ore reserves without first completing a feasibility report, the subsequent reclassifications will be lower than would have been had the firm waited, manifesting in a smaller co-efficient for contingent resources in my reserve revision tests.

Ferguson *et al*. (2013) also document that 65.9% of their sample did not disclose reserve estimates in the feasibility report, however Ferguson *et al*. (2013) note that this percentage is likely due to the reserve estimates being disclosed on a previous occasion. This speculation is anecdotally consistent with the Adamus Ltd 2008 annual report, where the reserve estimates and feasibility report are disclosed in separate tables, reproduced as Tables 2 and 3 on page 116, even though the two clearly correspond by both referring to twelve million tonnes of ore reserves and life of mine production respectively.

For the purposes of my thesis, I utilise whatever information was publically available as at a given date, regardless of whether it is from the same document. Following a similar approach, Mirza and Zimmer (2001) investigate mining firms that do not disclose reserve estimates, finding the decision to disclose is associated with firm size, project development, debt financing, and cross-listing. My study only includes firms with reserve estimates, with 51 observations (7.2%) excluded as non-disclosing producers.[109] The findings in Mirza and Zimmer (2001) suggest my sample is biased towards larger, established firms. Given that larger established firms tend to be more active with resource estimate revisions, my sample is therefore biased towards finding a result within a smaller revision horizon. This bias therefore reduces the likelihood of a type II error. While the bias also exaggerates the magnitude of contingent resources that are reclassified as ore reserves within a given revision horizon, the effect of project development on revision activity is well understood within the mining industry.

4.4.6 Non-linearity

OLS regressions are based on the assumption that there is a linear association between the LHS and RHS variables. In the case of my reserve revision regressions, with change in reserves on the LHS and estimates of resources on the RHS, the underlying phenomena are likely to be non-linear. For the conversion of contingent resource estimates into reserves over time, the effect is likely to resemble an S-curve with asymptotes at 0% (no conversion) and 100% (full conversion). Initially, the conversion rate is small because there is an insufficient increase in the gold price to justify the reclassification of contingent resource estimates as reserves. As the accumulated gold price increase passes a critical level, portions of the contingent resources become commercially viable, and the conversion rate increases. Eventually, after sustained gold

[109] See Table 8A.

price increases, all the contingent resources will be converted into reserves, and the conversion rate decreases to zero.

Similar to contingent resource estimates, the conversion of inferred resource estimates into developed resources over time is likely to resemble an S-curve with asymptotes at 0% and 100%. Initially, the conversion rate is small because there has been insufficient exploration to justify the reclassification of inferred resource estimates as developed resources. As the exploration accumulates and a critical level is passed, portions of the inferred resource estimates attain a reasonable level of geological confidence, and the conversion rate increases. Eventually, after sustained exploration, all the inferred resources will be converted into developed resources, and the conversion rate decreases to zero. Although further exploration yields further results and increases to developed resources, this would not be the conversion of *ex ante* estimates of inferred resources.

The non-linear nature of the underlying phenomena impedes both the likelihood of finding a result, increasing the likelihood of a type II error, and also impedes the ability to interpret the estimated co-efficients. A type II error can occur if the sample observations used in my tests are mostly located at either end of the S-curves, where the conversion rates are expected to be zero. Given the sustained gold price increases in the later sample period, reported in Figure 5, it is unlikely that extreme observations will dominate the sample when testing H_{2a}. Assuming that exploration activity varies in direct proportion to gold price movements, because *ceteris paribus* gold price increases increase the commercial viability of all deposits, it is also unlikely that extreme observations will dominate the sample when testing H_{3a}.

Although it is possible to infer the statistical significance, relative to a null association, of an underlying non-linear phenomenon from the results of linear tests, it is not possible to accurately generalise economic significance without a detailed analysis of the sample characteristics. Even with non-linear tests, it is difficult to generalise economic significance beyond the sample because (a) mineral deposits are in limited supply, (b) mineral deposits differ in characteristics, and (c) there are clear economic incentives to exhaust the most commercially viable deposits first. The prospect of situations like 'peak oil,' whereby mineral production surpasses the maximum level allowed within current and expected future reserves, highlight a limitation with inferring the average future revision of reserves from average past revisions.

5.0 <u>Results</u>

5.1 The components of estimates of total resources

Table 13A reports the regression results from Equation (1), comparing *ex post* change in future reserve estimates to current reserve (β_1) and mineralised material estimates (β_2) and *ex post* future project acquisition (β_3, and the interaction with reserves β_4), for future periods of one to ten years, with a sample that includes SEC firms. The co-efficient for current reserves is significantly positive for the periods T=2 to T=5 ($p < 0.1$), suggesting that in the medium-term, the average growth in reserves is significantly greater than zero. However, the co-efficient for current reserves declines and is significantly negative for period T=10 ($p = 0.09$), suggesting that in the long-term, the average growth in reserves declines to significantly less than zero.[110] Consistent with the views of the SEC, β_2 is insignificantly different to zero in every regression ($p > 0.2$), suggesting estimates of mineralised material are not useful in predicting the future change in reserves, and thus production and operating cash flows. The interaction between reserves and future project acquisition (β_4) is significantly positive from T=3 onwards ($p < 0.05$), highlighting the importance of project acquisition in expanding the reserve inventory.[111]

Table 13B reports the regression results from re-running Equation (1) with a sample that excludes SEC firms. Similar to Table 13A, β_1 is significantly positive in the medium-term ($p < 0.05$). Contrary to Table 13A, β_1 remains significantly positive in the

[110] The small sample size in period T=10, 77 firm-year observations, does reduce generalisability.
[111] See Section 4.1 'Sample and Data Sources' for a limited discussion of the prevalence of firm acquisition within the sample.

long-term ($p < 0.05$), possibly due to survivorship bias or estimate conservatism. Offsetting the stronger result for β_1 in Table 13B, β_4 declines from T=8 onwards, becoming insignificant in T=10 ($p = 0.116$). Most importantly, β_2 is significantly positive over the medium-term ($p < 0.01$), but not the long-term ($p > 0.01$). While the magnitude of the insignificant long-term β_2 is greater than the magnitude of the significant medium-term β_2, the decline in statistical significance suggests while the average conversion of contingent resources into reserves increases over time, so does the dispersion, implying that the reliability of contingent resource estimates as a proxy for future reserves is low. Overall, the results in Table 13B compared to Table 13A suggest that the change in future reserve estimates for firms that report under SEC Industry Guide 7 is associated less with current estimates than is the association for firms that report outside of SEC Industry Guide 7, consistent with the onerous nature of the restrictive guide.

Table 13C reports the regression results from Equation (2), decomposing total resources into reserves (β_1), contingent resources (β_2) and inferred resources (β_3), with a sample that necessarily excludes SEC firms. Contingent resources are significantly positive for T=1 to T=2 ($p < 0.1$) but insignificant thereafter ($p > 0.1$), providing limited evidence of informativeness. The co-efficients suggest, on average, roughly 12% of contingent resources are converted into reserves, but the variation in outcomes suggests this average is unreliable. Inferred resources are significantly positive for T=3 to T=6 ($p < 0.05$) but insignificant before and after ($p > 0.2$) – also providing limited evidence of informativeness. The co-efficients suggest, on average, roughly 27% of inferred resources are converted into reserves, but the variation in outcomes suggests this average is unreliable. The *F*-test reports that β_2 is greater than β_3 for T=1 ($p < 0.01$), but β_3 is greater than β_2 for T=4 ($p < 0.1$), therefore providing only limited evidence in support of the professional mining community and H_{1a}, a significant difference between the predictive ability of estimates of contingent and inferred resources.

Table 14 reports the regression results from Equations (3) and (4), examining the price-sensitivity of different estimates of resources. Panel i/ii examines estimates of reserves (β_1) and mineralised material (β_2), with a sample that includes/excludes SEC firms. The two co-efficients of interest appear similar across the two samples, with β_1 significantly positive ($p < 0.05$) and roughly comparable to an average operating profit margin (β_1 = 16.8% and 29.6%), but β_2 is significantly less than zero ($p < 0.001$), roughly equal to -5%. Panel iii examines estimates of reserves (β_1), contingent resources (β_2) and inferred resources (β_3), with a sample that necessarily excludes SEC firms. Similar to Table 13C, β_2 and β_3 are not significantly different to zero ($p > 0.2$) and not significantly different to each other ($p = 0.864$), therefore providing evidence for the SEC and against H_{1b}, no significant difference between the price-sensitivity of estimates of contingent and inferred resources.

As for the control variables, all are insignificant in panel i ($p > 0.1$). By-products is significantly negative in panels ii and iii ($p < 0.01$) despite a predicted value of positive one, suggesting the percentage of gold focus may be associated with other aspects of the value of gold deposits, similar to the gold beta results in Tufano (1998). The book value of equity, minus sunk costs and expected capital expenditure, is significantly positive ($p < 0.001$) with a co-efficient of 1.88 being similar to the predicted value of positive one. Sunk costs are also significantly positive ($p < 0.001$) with a co-efficient of 1.39 being larger than the predicted value of the marginal tax rate. Expected capital expenditure is not significantly positive ($p > 0.1$) even though the co-efficient estimate of two is larger than the predicted value of the marginal tax rate. The large co-efficients for sunk costs and expected capital expenditure are too large to be solely explained by the scrap value of these assets, although similar results have been reported in other studies.[112]

5.2 Gold price movements

Table 15A reports the regression results from Equation (5), testing H_{2a} by including percentage *ex post* gold price movement (*GoldMove*) into the *ex post* change in future reserve estimates regression. Confusingly, the interaction of *GoldMove* with reserve estimates is significantly negative in some periods (T=6-9, $p < 0.1$). The

[112] Magliolo (1986) reports co-efficients for the book value of mining assets ranging from -0.391 to 4.851, Harris and Ohlson (1987) from 0.49 to 3.40, and Zhou *et al*. (2011) from -6.052 to 9.194.

interaction of *GoldMove* with contingent resource estimates is insignificant in the early periods (T=1 to T=4, $p > 0.1$) and significantly positive in the later periods (T=5-10, $p < 0.1$). This result provides strong evidence in support of H_{2a}, the predictive ability of estimates of contingent resources is positively associated with [sustained] *ex post* gold price movements.

Table 15B reports the regression results from Equation (6), a piece-wise decomposition of *GoldMove* into positive and negative values (*PosGold* and *NegGold* respectively).[113] While the interactions of *PosGold* and *NegGold* with reserve estimates are mostly insignificant, strangely these co-efficients are significantly negative in some periods (T=1 and T=6 to T=9, $p < 0.1$). The interaction of *PosGold* with contingent resource estimates is significantly positive for T=6 to T=10 ($p < 0.1$), suggesting sustained gold price increases are positively associated with the conversion of contingent resources into reserves, which is consistent with the resource reporting framework and H_{2a}. The interaction of *NegGold* with contingent resource estimates is insignificant for most periods (except T=1, T=6 and T=8; $p > 0.3$), suggesting gold price decreases do not relate to the conversion of contingent resources into reserves, which is also consistent with the resource reporting framework.

Table 15C reports the regression results from Equation (7), including estimates of inferred resources. With the exception of period T=3, the interaction of inferred resources with either *PosGold* or *NegGold* is always insignificant ($p > 0.1$), suggesting gold price movement is not associated with the conversion of inferred resources into reserves. Overall, the results from Table 15C highlight the difference between estimates of contingent resources and estimates of inferred resources vis-à-vis their conversion into reserves, a distinction not possible under SEC Industry Guide 7.

While Tables 15A, 15B and 15C include *ex post* gold price movements, which are not known in advance, Table 15D reports the regression results from Equation (8),

[113] Note that the results for T=9 and T=10 in Table 14B are identical to Table 14A as there is no nine or ten year period within my sample for which the accumulated gold movement was negative, emphasising the limited generalisability of my long-term results.

substituting lagged gold price movement for *ex post*.[114] Over the short to medium-term (T=1 to T=4), both positive and negative lagged gold price movement are not associated with the future conversion of contingent resources into reserves ($p > 0.1$). Over the long-term (T=6 onwards), negative lagged gold price movement is negatively associated with the future conversion of contingent resources into reserves ($p < 0.05$), consistent with a mean reverting association between lagged and future gold price movement. For the short-term (T=1-2) and the long-term (T=6 onwards), lagged gold price movement is not significantly associated with the conversion of inferred resources into reserves ($p > 0.3$). Overall, the results from Table 15D (compared to Table 15C) suggest that lagged gold price movements are a poor proxy for future gold price movements, consistent with Figure 3.

Table 16A reports the regression results from Equation (9), testing H_{2b} by including percentage lagged *GoldMove* into a value relevance regression. While reserve estimates are significantly positive in half the regressions (T=1-2 and T=8 onwards, $p < 0.05$), the interaction of reserves with lagged *GoldMove* (β_3) is always significantly positive ($p < 0.001$). While estimates of contingent resources are significantly positive in the latter half of the regressions ($p < 0.1$), the interaction of contingent resources with lagged *GoldMove* (β_5) is always significantly negative ($p < 0.1$). These two results are somewhat inconsistent. A positive β_3 is consistent with perceived momentum in the gold price, because the lagged gold price movement is expected to continue. A negative β_5 is consistent with perceived mean reverting gold price, because the lagged gold price movement is expected to reverse. When the gold price has decreased, some marginal reserves are reclassified as reserves, but as this may reverse if the gold price reverses, contingent resources are more valuable than usual. When the gold price has increased, the marginal resources in contingent resources have been reclassified as reserves, with only the truly uncommercial low value resources remaining.

[114] Note the absence of lagged *PosGold* for T=8-10 as there is no lagged eight year period within my sample for which both the accumulated gold movement was positive prior to observations from 2000, required for eight years of subsequent changes in reserves in a sample ending in 2008, once again emphasising the limitation on the generalisability of my long-term results.

Table 16B reports the regression results with the piece-wise decomposition of lagged *GoldMove*. The positive and negative gold movement interactions with reserves estimates are insignificantly different for T=1-3, T=5-6 and T=8-10 ($p > 0.1$), but the co-efficient on *PosGold*SResv*, significantly positive in all periods ($p < 0.05$), is only significantly greater than *NegGold*SResv* for T=4 and T=7 ($p < 0.05$). The negative gold movement interactions with estimates of contingent resources are insignificantly different for T=1-2 and T=5 onwards ($p > 0.1$), but the co-efficient on *PosGold*SCon*, significantly negative in all periods ($p < 0.1$), is significantly less than *NegGold*SCon* for T=3-5 and T=8-10 ($p < 0.05$). The co-efficient on the non-interacted estimates of contingent resources are significantly positive in the medium-term (T=3-6, T=8, $p < 0.1$) but insignificant at each extreme (T=1-2, T=7, T=9 onwards, $p > 0.1$). Overall, the interactions with lagged gold price movement are mostly significant for the lagged positive movement, not the negative.

Table 16C reports the regression results from Equation (11), including estimates of inferred resources into a value relevance regression with piece-wise lagged *GoldMove*. The co-efficient for the interaction of inferred resource estimates with *PosGold* is significantly positive for T=2-3 and T=7 ($p < 0.1$), but the co-efficient is insignificant in other periods ($p > 0.1$). The *NegGold*SInf* co-efficient is insignificant in all periods ($p > 0.3$), most likely as gold exploration activity is reduced during a slump in the gold price. Overall, the results from Table 16C highlight the difference between estimates of contingent resources (negative interaction with *PosGold*) and estimates of inferred resources (negative interaction with *NegGold*) vis-à-vis their conversion into reserves, a distinction not possible under SEC Industry Guide 7.

5.3 Exploration expenditure

Table 17A reports the regression results from Equation (12), testing H_{3a} by examining the *ex post* change in future estimates of developed resources. The co-efficient for inferred resources is insignificant in every period ($p > 0.1$) suggesting inferred resources are not reliably converted into developed resources – consistent with the explicit warning in the JORC Code. Table 17B reports the regression results from Equation (13), testing H_{3a} by including *ex post* cumulative exploration expenditure into the *ex post* change in future estimates of developed resources regression. The co-efficient for the interaction of exploration expenditure with developed resources is significantly positive in all periods except T=10 ($p < 0.1$), which is consistent with exploration expenditure including evaluation expenditure, the evaluation of the commercial viability of resources. The co-efficient for the interaction of exploration expenditure with inferred resources is insignificantly different to zero for periods T=1 to T=7 ($p > 0.1$), but significantly positive from thereafter ($p < 0.5$), suggesting the conversion of inferred resources to developed resources is not automatic, but requires sustained exploration expenditure.

Table 17C reports the regression results from Equation (14), decomposing developed resources into reserves and contingent resources. Strangely, the co-efficient for the interaction of exploration expenditure with reserves in significantly positive for the periods T=1 to T=7 ($p < 0.1$), even though reserves by definition are already well explored and evaluated as commercial. Production firms also revise their reserve estimates based on the realised recovery rates from the production process. Conversely, the co-efficient for the interaction with contingent resources is insignificant for the periods T=1 to T=8 ($p > 0.1$). The co-efficient for the interaction with inferred resources is similarly insignificant for the periods T=1 to T=5 ($p > 0.2$), but is significantly positive thereafter ($p < 0.1$), confirming that the conversion of inferred resources to developed resources requires sustained exploration expenditure.

While Tables 17A, 17B and 17C include *ex post* cumulative exploration expenditure, which is not known in advance, Table 17D reports the regression results from Equation (15), substituting the last year's expenditure for *ex post*. The result for the interaction with inferred resources is similar to Table 17C, but weaker; the co-efficient is insignificant for the periods T=1 to T=8 ($p > 0.4$) but significantly positive thereafter ($p < 0.1$). This result suggests that last year's exploration expenditure is a weak proxy for future expenditure, despite the strong serial correlation reported in Table 12B.

5.4 The proportion of developed resources that are reserves

Table 18A reports the regression results from Equation (16), testing H_{4a} by including an interaction between estimates of inferred resources, exploration expenditure, and the proportion of developed resources that are reserves. The proportion of developed resources that are reserves is proxies for the economic viability of the deposit, and thus a rough proxy for the economic viability of inferred resources. The co-efficient for the interaction of inferred resources with exploration is mostly insignificantly different to zero (except for T=8, $p > 0.1$). Similarly, the co-efficient for the interaction of inferred resources with exploration expenditure and the proportion of developed resources that are reserves is mostly insignificantly different to zero ($p > 0.1$), except for T=8. In contrast, the interaction of inferred resources with the proportion of developed resources that are reserves is significantly positive for T=7 onwards ($p < 0.1$). The results in Table 18A contrast with the results in Table 17C by emphasising the proportion of developed resources that are reserves, rather than exploration expenditure, in the conversion of estimates of inferred resources into reserves.

As a three-way interaction introduces multi-collinearity issues into the regressions, I rerun Equation (16) without the interaction of inferred resources with exploration expenditure, with results reported in Table 18B. As before, the interaction of inferred resources with the proportion of developed resources that are reserves is significantly positive for T=7 onwards ($p < 0.1$). However now the co-efficient for the interaction of inferred resources with exploration expenditure and the proportion of developed resources that are reserves is also significantly positive for T=6 onwards ($p < 0.1$), consistent with H_{4a}, suggesting the commercial viability of current developed resources is a useful indication of the likely commercial viability of inferred resources.

Similar to Table 17D, Table 17C reports the regression results from Equation (17), substituting the last year's exploration expenditure for *ex post*. The interaction of inferred resources with the proportion of developed resources that are reserves is always insignificantly different to zero ($p > 0.1$). The co-efficient for the interaction of inferred resources with exploration expenditure and the proportion of developed resources that are reserves is always significantly positive, ($p < 0.05$), except for T=10. This result suggests that the inclusion of the proportion of developed resources that are reserves somewhat improves the utility of last year's exploration expenditure as a proxy for future expenditure.

Table 19 panel i reports the regression results from Equation (18), testing H_{3b} by including an interaction between estimates of inferred resources and current exploration expenditure in a price-sensitivity regression. The co-efficients for both the estimates of inferred resources and the interaction with exploration expenditure are both insignificantly different to zero ($p > 0.4$).

Table 19 panel ii reports the regression results from Equation (19), testing H_{4b} by including an interaction between estimates of inferred resources and exploration expenditure, and the proportion of developed resources that are reserves, in a price-sensitivity regression. The co-efficient for estimates of inferred resources is insignificantly different to zero ($p > 0.2$) , as well as the interaction with the proportion of developed resources that are reserves ($p > 0.1$) and the co-efficient for the interaction with exploration expenditure is marginally significant ($p = 0.099$). However, the co-efficient for the interaction between estimates of inferred resources and exploration expenditure, and the proportion of developed resources that are reserves is significantly positive ($p < 0.1$), consistent with H_{4b}.

5.5 Additional tests

5.5.1 The proportion of mineralised material that is inferred resources

To test the ability to estimate the proportion of mineralised material that is inferred resources (*i.e.*, a multiplicative disaggregation of mineralised material), prohibited by SEC Industry Guide 7, using other information that is allowed by the SEC, I regress this proportion on an indicator variable for developer firms (*Devpr*), the proportion of reserves to total resources (*Resv/Resc*), and the rate of production (*Prod*), as well as the determinants of *Inf* and *Con* ($Expl_t$ and $GoldMove_{t-T}$).

$$Inf_{i,t}/MinMat_{i,t} = \beta_0 + \beta_1 Devpr_{i,t} + \beta_2 Expl_{i,t} + \beta_3 Devpr_{i,t} * Expl_{i,t} + \beta_4 Resv_{i,t}/Resc_{i,t} + \beta_5 Devpr_{i,t} * Resv_{i,t}/Resc_{i,t} + \beta_6 Prod_{i,t} + \varepsilon_{i,t+T} \quad (20)$$

$$Inf_{i,t}/MinMat_{i,t} = \beta_0 + \beta_1 Devpr_{i,t} + \beta_2 GoldMove_{i,t-T} + \beta_3 Devpr_{i,t} * GoldMove_{i,t-T} + \beta_4 Resv_{i,t}/Resc_{i,t} + \beta_5 Devpr_{i,t} * Resv_{i,t}/Resc_{i,t} + \beta_6 Prod_{i,t} + \varepsilon_{i,t+T} \quad (21)$$

$$Inf_{i,t}/MinMat_{i,t} = \beta_0 + \beta_1 Devpr_{i,t} + \beta_2 PosGold_{i,t-T} + \beta_3 NegGold_{i,t-T} + \beta_4 Devpr_{i,t} * PosGold_{i,t-T} + \beta_5 Devpr_{i,t} * NegGold_{i,t-T} + \beta_6 Resv_{i,t}/Resc_{i,t} + \beta_7 Devpr_{i,t} * Resv_{i,t}/Resc_{i,t} + \beta_8 Prod_{i,t} + \varepsilon_{i,t+T} \quad (22)$$

$$Inf_{i,t}/MinMat_{i,t} = \beta_0 + \beta_1 Devpr_{i,t} + \beta_2 Expl_{i,t} + \beta_3 Devpr_{i,t} * Expl_{i,t} + \beta_4 PosGold_{i,t-T} + \beta_5 NegGold_{i,t-T} + \beta_6 Resv_{i,t}/Resc_{i,t} + \beta_7 Devpr_{i,t} * Resv_{i,t}/Resc_{i,t} + \beta_8 Prod_{i,t} + \varepsilon_{i,t+T} \quad (23)$$

Developer firms are predicted to have a higher proportion of inferred resources because these firms' projects are less developed. Similarly, firms with a high proportion of reserves to total resources are predicted to have a lower proportion of inferred resources because these firms' projects are more developed. Firms with a higher rate of production are predicted to have a lower proportion of inferred resources because they are approaching the end of the mine life.

The first panel of Table 20 reports the regression results from Equation (20), examining the ability to predict the decomposition of mineralised material, the disclosure of which is prohibited by SEC Industry Guide 7, using other information which is allowed by the SEC, including exploration expenditure. To distinguish between developers and producers, an indicator variable is included for developers (*Devpr.*) and is also interacted with the other variables.[115] The intercept is significant ($p < 0.001$) and with a value of 0.589 is close to the mean proportion of mineralised material that is inferred resources reported in Table 11B (58.4%). As the RHS variables are not standardised to a mean of zero, the similarity between the intercept and the mean is concerning. For producers (based on the non-interacted variables), all RHS variables are insignificantly different to zero ($p > 0.2$). For developers, the indicator variable is significantly positive ($\beta_1 = 0.162$, $p < 0.01$) and the interaction of the proportion of reserves to resources is significantly negative ($p < 0.1$). As the interaction with exploration expenditure, representing the difference between producers and developers, is insignificant ($p > 0.2$), the second panel of Table 20 reports the regression results from Equation (20) excluding the non-interacted exploration expenditure. Now the interaction of developers with exploration expenditure is significantly positive ($p < 0.05$). Overall, these results indicate that while other information which is allowed by the SEC can provide some indication of the proportion of mineralised material that is inferred resources for developers, it provides no reliable indication for producers. In other words, the mineralised material of pre-commencement projects (developers) can be modelled somewhat, but the cumulative effects of years of production and exploration of commenced projects (producers) creates enough variation to hinder the modelling.

Table 21A reports the regression results from Equation (21), examining the ability to predict the proportion of mineralised material that is inferred resources using other information including the publically available lagged gold price movement. This time, the regressions do report significant co-efficients for producers, albeit with a low adjusted R^2 of roughly 0.03. Contradicting the expected result, the co-efficient for lagged *GoldMove* is always significantly negative ($p < 0.1$), although the interaction with developers is mostly significantly positive ($p < 0.1$), except for T=8 onwards. Table 21B piece-wise decomposes lagged *GoldMove* into positive and negative components, with

[115] The co-efficients of the non-interacted variables therefore represent producers, while the co-efficients for the interacted variables represent the difference between developers and producers.

most of the effect relating to *NegGold* . This overall result suggests that while developers are inclined to report estimates of their marginal resources as contingent resources, consistent with the reporting framework, producers are more inclined not to report these estimates at all, *i.e.*, consistent with a more conservative interpretation of the reporting code's notion of "reasonable prospects for eventual economic extraction."

Overall the results demonstrate a benefit of the separate reporting of contingent and inferred resources as encouraged under the JORC Code, SME Guide and NI 43-101. The SEC presently does not allow for the disaggregation of 'mineralized material' into contingent resources and inferred resources, reducing the informativeness of resource disclosures by affected firms.

5.5.2 Separate time periods: 1995-2000 and 2001-2008.

My sample period covers the years 1995 to 2008. Some changes that occurred during this period that may affect the results and their generalisability are (a) the switch in resource reporting codes in Canada from NPS 2-A to the more detailed CIM Definition Standards / NI 43-101, effective February 2001, and (b) the change in gold price trends from mean reversion to upward momentum around 2000-2001. Tables 22A/B, 22C/D, 22E/F and 22G report the regression results from the reserve revision Equations (6), (16), (10) and (19) respectively, analysing separate sub-samples for the periods 1995-2000 / 2001-2008.

In Table 22A, the key results resemble the corresponding results in Table 15B: the interaction of *PosGold* with *Con* is positive and significant for T=6 onwards ($p < 0.1$), and the interaction of *NegGold* with *Con* is mostly insignificant. In Table 22B, these interactions are always insignificant ($p > 0.1$). Data for *NegGold* only exists in the later period for T=1 as one of the characteristics of that period is an upward trend in the gold price. The later period sub-sample is quite small from T=7 onwards due to the limited number of observations from 2001 and 2002 that continued for seven or more years (eighteen and sixteen respectively). Most of the observations for T=7 onwards in Table

15B are from the years prior to 2001, and this is why the results for T=7 onwards in Table 22A resemble the corresponding results in Table 15B.

In Table 22C, the key results are stronger than the corresponding results in Table 18B: the interaction of *Inf* with *Resv* / *Dev* is positive and significant for T=4 onwards ($p < 0.1$), and the interaction of *Inf* with *Resv* / *Dev* and *Expl* is positive and significant for T=1-3, T=6 and T=8 onwards ($p < 0.1$). In Table 22D, these interactions are mostly insignificant, and even significantly negative for the small sub-sample tests (T=7-8). From the perspective of the change in reporting codes, the positive results for early estimates of inferred resources but not later estimates is counter to expectations, because the later estimates, compliant with the CIM Definition Standards / NI 43-101 are supposedly more reliable than the early estimates based on NPS 2-A. From the perspective of the change in gold price trends, the significant early (insignificant late) result may be a reflection of conservative (aggressive) exploration activity when the gold price was relatively low (high).

Overall, the results from my additional tests in Table 22 demonstrate that the results in my main tests are driven by (a) resource estimates from 1995-2000, (b) gold price increases from 2001-2008, and (c) exploration activity from 1995-2000. More firm and year data would be required for a proper comparison of the two sub-periods in isolation, as it can take several years for (a) gold price increases, (b) exploration activity and (c) estimates of inferred resources, to yield reserve estimates.

In Table 22E, the key results do not resemble the corresponding results in Table 16B because in Table 22E both the interactions of *Con* with *PosGold* and *NegGold* are mostly insignificant. In Table 22F, the interaction results do resemble Table 16B, with the *PosGold* interaction being mostly significantly negative and the NegGold interaction being mostly insignificant. Unlike in Table 16B, the non-interacted estimates of contingent resources are mostly positively significant in Table 22F. The results in Tables 22E and 22F, for market prices from 1995-2000 and 2001-2008 respectively, suggest that estimates of contingent resources are price-sensitive during the later period, when there was an upward trend in the gold price and Canadian estimates were compliant with the CIM Definition Standards / NI 43-101, but not price-sensitive in the early period, when there was a mean reverting gold price and Canadian estimates were compliant only with NPS 2-A. However, the value of contingent resources declines when there has been gold price increases, most likely because the marginal component of contingent resources is reclassified as ore reserves, leaving the stale component behind.

In Table 22G panel i, the key results do not resemble the corresponding results in Table 19 panel ii because in Table 22G panel i, the interaction of inferred resources with exploration expenditure is significantly positive ($p < 0.05$) while the interaction of inferred resources with exploration expenditure and the proportion of developed resources that are ore reserves is insignificant ($p > 0.2$). In Table 22G panel ii, all of the variables based on the estimates of inferred resources are insignificant ($p > 0.2$), although the interaction of inferred resources with exploration expenditure and the proportion of developed resources that are ore reserves is quite large ($\beta_{10} = 19.216$). The results in Table 22G suggest that while exploration activity is always important when valuing inferred resources, the proportion of developed resources that are ore reserves is only important when the gold price is trending upwards, not when it is mean reverting.

5.5.3 Utilising the market price from three months after the financial year end

Tables 23A and 23B report the regression results from Equations (4), (10), (18), and (19) utilising the market price from three months after the financial year end, similar to Boone (2002) and Zhou *et al*. (2011), instead of six months after. Table 23A panel i corresponds to Table 14 panel iii. The adjusted R^2 from the model in Table 23A panel i, utilising the market price from three months after, is only 0.667, compared to 0.902 in Table 14 panel iii utilising the market price from six months after. Corresponding with this drop in the adjusted R^2, most variables are insignificant in Table 23A panel i ($p > 0.1$), despite larger co-efficients, and the intercept co-efficient is now significant ($p < 0.1$). Table 23A panels ii and iii correspond to Table 18 panels i and ii respectively.

These results are also consistent with Table 23A panel i, a drop in the adjusted R^2 (from 0.901 and 0.906 to 0.664 and 0.690) and insignificant variables with larger co-efficients (*i.e.*, the larger co-efficient is surpassed by the greater standard error).

Table 23B corresponds to Table 16B. Similar to Table 23A, Table 23B reports a lower adjusted R^2 than its counterpart, Table 16B (from 0.90-0.94 to 0.68-0.80). Table 23B also reports significant intercept co-efficients ($p < 0.05$) and many insignificant control variables. The co-efficients for the gold price interactions are similar across Tables 16B and 23B. Strangely, the co-efficients for the two important variables, *SResv* and *BVE*, are either insignificant or significantly negative. Overall, the poor results from this sensitivity test are consistent with my motivations behind utilising the market price six months after: small and medium sized mining firms can take more than three months to disclose their annual reports, and this delay is exacerbated by a slow price discovery process. Strangely, the majority of other price-sensitivity studies utilise market values contemporaneous to reserve estimates, allowing no time for the disclosure of these estimates, although this timing issue may not be as important in settings with quarterly reporting.

6.0 Conclusion

I investigate the information content of the resource estimate categories prohibited by SEC Industry Guide 7 (contingent resources and inferred resources) and its impact upon the information environment of mining firms. My objective is to test (i) whether the prohibited categories are useful in predicting future revisions to reserve estimates, and (ii) whether the prohibited categories are price-sensitive, as well as (iii) the conditions under which the prohibited categories are reclassified as reserves. Following the framework of resource reporting codes such as the JORC Code and CIM Definition Standards, I also separately examine the impact of relevant variables on the informativeness of the two prohibited categories. As contingent resources are defined as resources that are not commercially viable under current conditions, I examine the impact of gold price movements on the informativeness of estimates of contingent resources. As inferred resources are defined as resources that are based on preliminary estimates, I examine the impact of exploration expenditure on the informativeness of estimates of inferred resources. As inferred resources (commercially unverified) can be reclassified as either ore reserves (commercially viable) or contingent resources (commercially unviable), I examine the impact of the relative proportion of ore reserves and contingent resources on the informativeness of estimates of inferred resources.

My first hypothesis states that estimates of contingent resources and inferred resources are useful in predicting future reserves and are also price-sensitive. While I report limited evidence of their predictive ability, I find no supporting evidence for their price-sensitivity. A naïve prediction (*i.e.,* without explanatory variables) suggests that, on average within my sample, 12% of contingent resources are reclassifed into reserves, but the variance is relatively high beyond a horizon of two years. A similar naïve prediction suggests that 27% of inferred resources are reclassifed into reserves, but the variance is relatively high before three years and after six years.

Moving on to examining the causes of reclassification, my second hypothesis states that gold price movements are related to the informativeness of estimates of contingent resources. I find evidence that sustained *ex post* increases in the gold price are associated with estimates of contingent resources (commercially unviable) being *ex post* reclassified as ore reserves (commercially viable). I report a negative association between the price-sensitivity of contingent resources and lagged increases in the gold price, which may be a reflection of the difficulty in utilising lagged gold price movement as an *ex ante* proxy for future gold price movement.

My third hypothesis states that exploration is related to the informativeness of estimates of inferred resources. I find evidence that sustained *ex post* exploration expenditure is associated with estimates of inferred resources (preliminary) being *ex post* reclassified as developed resources (ore reserves and contingent resources). However, I find no supporting evidence for current exploration expenditure being associated with the price-sensitivity of inferred resources. My fourth hypothesis states that the relative commercial viability of existing developed resources is also related to the informativeness of estimates of inferred resources. I find evidence that the relative commercial viability of existing developed resources combined with sustained *ex post* exploration expenditure is associated with estimates of inferred resources being *ex post* reclassified as developed resources. I also find evidence that the relative commercial viability of existing developed resources combined with current exploration expenditure is associated with the price-sensitivity of inferred resources.

The restrictions of SEC Industry Guide 7 may not be onerous if investors can obtain similar information from other sources. In additional tests, I examine the ability to predict the decomposition of estimates of mineralised material (into contingent resources and inferred resources) using only publically available information that is not prohibited by SEC Industry Guide 7. For producers (firms with active production), I find very weak evidence in support of using other information to decompose mineralised material. For developers (firms with reserves but no active production), while more variables help to predict the decomposition, the overall power is not economically significant.

I also examine the impact of different sub-periods, corresponding to changes in resource reporting codes and changes in gold price trends, and the impact of different time lags between the reporting date and the valuation date. Overall, my results suggest that, while estimates of contingent resources and inferred resources do not appear to be informative by themselves, when combined with their respective value-drivers, the resource categories prohibited by SEC Industry Guide 7 can be informative. It may take several years for mineralised material to be significantly converted into ore reserves, but it does happen.

My findings contradict the assumptions underlying the prohibition of the disclosure of uncommercial and preliminary resource estimates in SEC Industry Guide 7. While naïve prediction of the reclassification of uncommercial and preliminary resource estimates appears low and unreliable, proper consideration of the distinct causes of this reclassification yields fruit. The SEC has restricted the disclosure of resources that lack economic viability because the SEC believes these estimates to be 'misleading' to unsophisticated investors. Ironically, by distorting the disclosure of useful information, the SEC is increasing to investor confusion.

The SEC prohibition contradicts the push towards international harmonisation by major reporting codes such as the JORC Code and CIM Definition Standards, as well as ignoring the USA's own professional mining body. The SEC prohibition is also consistent with a broader trend of tension between the SEC requiring conservative reporting supposedly to protect unsophisticated investors, and other regulatory bodies encouraging neutral reporting supposedly to assist the broader capital markets.

It should be noted that the SEC's concerns technically do not relate to the marginal investor, but to unsophisticated investors. However, it should also be noted that protecting unsophisticated investors by prohibiting the disclosure of relevant information has its costs. By prohibiting the disclosure of relevant information, the SEC is reducing the ability for mining firms to reduce information asymmetry and their cost of capital, and thereby reducing their access to capital funds to expand operations and weakening their ability to create jobs. The prohibition on the disclosure of contingent resources particularly hurts firms with significant deposits of marginal (almost commercially viable) resources. The prohibition on the disclosure of inferred resources particularly hurts expanding firms with significant deposits of undeveloped resources.

The reporting of mineral resource estimates, as with accrual-based financial reporting,[116] is subject to the oft competing considerations of information relevance (including timeliness) and reliability (including representational faithfulness). Resource reporting codes provide a framework which attempts to reconcile relevance and reliability. By allowing multiple categories of mineral resource estimates (explicitly based on commercial and geological confidence, as outlined in professional reporting codes), the users of this information can decide for themselves how much weight to place

[116] Statement of Financial Accounting Concepts (SFAC) No. 2 "Qualitative Characteristics of Accounting Information."

on different categories. However users can only make this decision if the categories are disclosed or by obtaining the information through costly means.

As a piece of positive social science, this thesis can only inform, not conclude regulatory debate. Even though I present evidence that the SEC prohibition on decomposing mineralised material reduces sophisticated investors' access to informative mining disclosure, this alone does not negate the possibility that unsophisticated investors are nonetheless being 'misled' and fixating on bottom-line figures. It falls to regulators, politicians and voters to decide how to address the competing interests of all affected parties, not only investors.

6.1 Limitations and future research

The ability to draw the above conclusions, from the results of the statistical tests employed, is subject to some inherent inferrability issues. The positive result for the predictive ability of low confidence inferred resources may be due to estimates of inferred resources being more confident than expected, inferred resources acting as a signal for expansion opportunities, a survivorship bias in the analysis of *ex post* revisions of inferred resources over a long-term horizon, or a systematic bias in the form of an industry practice of estimating low confidence resources with greater conservatism.

Another limitation is the utilisation of firm-level variables, as opposed to project level. To the extent that firms can own, acquire and dispose of, different types of projects that are unrelated, firm-level analysis can bias against finding a result. On the other hand, firm-level analysis can exacerbate the project-level survivorship bias as firms acquire good projects and dispose of bad projects. Firm-level analysis is necessary for the price-sensitivity tests, as well as the tests relating to exploration expenditure, because these variables are available only at the firm-level. Although firms can buy and sell projects, most investors can only buy and sell firms. Even at the project-level, projects can expand and contract in scope, adding and subtracting deposits and mineral formations.

Another limitation is the lack of adjustment for changes in the disclosed quantitative assumptions underlying the resource estimates (COG, top-cut grade, dilution factors, forecasted gold price, and forecasted production costs). Changes in these assumptions can bias for or against finding a result. Future research may wish to consider the causes and effects of these changes.

A limitation on the ability to interpret the value relevance of estimates of contingent and inferred resources from the tests I employ is the absence of any real options modelling. Some papers (Brennan and Schwartz, 1985; Colwell *et al.*, 2002) model estimates of contingent and inferred resources as though they were directly comparable to stock options, where the exercise price is based on the gold price required for the resource to be commercially viable. However, in reality, contingent and inferred resources do not have a single homogenous grade, but rather the reported grade is a weighted average and there is not a single exercise price for these real options. Within mining technical reports, this continuum is often communicated through a table demonstrating the sensitivity of grade and categorisation to commodity price assumptions.

All price-sensitivity research is subject to the limitation of the implicit double hypothesis relating to the valuation technique employed. Kraft *et al.* (2007) criticises Sloan (1996) as a joint test of both market (in)efficiency and the suitability of the price-sensitivity model employed (the Mishkin test). Barth (1991) points out the limitation of price-sensitivity research, such as my thesis, which attempts to infer estimate reliability from value-based regressions while assuming any error is uninformative white noise.

I investigate the respective predictive ability and value relevance of estimates of ore reserves, contingent resources and inferred resources. Future research might investigate further decompositions of the categories. For example, ore reserves and contingent resources can be further decomposed based on geological confidence into proven reserves, probable reserves, measured resources and indicated resources. Just as my findings challenge the SEC's prohibition on the disclosure of contingent and inferred resources, future research could investigate the JORC and the CIM/CSA's prohibition on the commercial evaluation of inferred resources as possible reserves. Future research might investigate the common practice of disclosing 'non-compliant' resource estimates from their acquired projects, disclosed under historical or foreign reporting codes not recognised by the JORC, CIM/CSA, SME or SEC.

As I provide evidence of the importance of identifying a signal for the likely commercial viability of the preliminary estimates of inferred resources, I would like to suggest that all professional and regulatory bodies reconsider their prohibition on the disclosure of possible reserves as the likely commercially viable portion of inferred resources. Although it is understandably risky to make offhand commercial assessments of inferred resources (with or without a formal feasibility study), sophisticated investors can process this information accordingly. As the reporting of possible reserves was common in Canada prior to NI 43-101, future research could examine the informativeness of this pariah category.

I have focused on the key difference between the JORC Code/NI 43-101 and SEC Industry Guide 7. There are some differences between the JORC Code and NI 43-101 which are currently being examined by the JORC and the ASX. NI 43-101 requires firms to disclose full technical reports within 45 days of disclosing a new mineral resource estimate. These technical reports include key quantitative assumptions utilised in the resource estimation process, including COGs, top-cut grades, and dilution factors. Technical reports also include sensitivity tests for these assumptions. Although the JORC encourages the disclosure of key assumptions, only the ASX is considering mandating the disclosure of technical reports. By disclosing sensitivity tests for key assumptions, report users, including researchers, can quantitatively identify and adjust for the effects of the related conservatism of the competent person issuing the estimate. Disclosing sensitivity tests also facilitates the dual considerations of estimate usefulness and comparability, when the underlying assumptions are changed as the situation changes.

Although not mandated by NI 43-101, the JORC and the ASX are considering mandating the industry best practice of disclosing resource reconciliation statements. By disclosing resource reconciliation statements, report users can quantitatively distinguish (a) endogenous improvements in the development of the deposit, (b) exogenous improvements in the commercial viability of the deposit, and (c) expansion of the deposit into additional areas.

Another difference between the JORC Code and NI 43-101 is that NI 43-101 requires firms to base their conversion of mineral resources to ore reserves on the conclusions of a publically disclosed feasibility report. As the purpose of the feasibility report is to demonstrate the commercial viability of a mining project, the public disclosure of these reports can be expected to reduce information asymmetry and the cost of capital.[117]

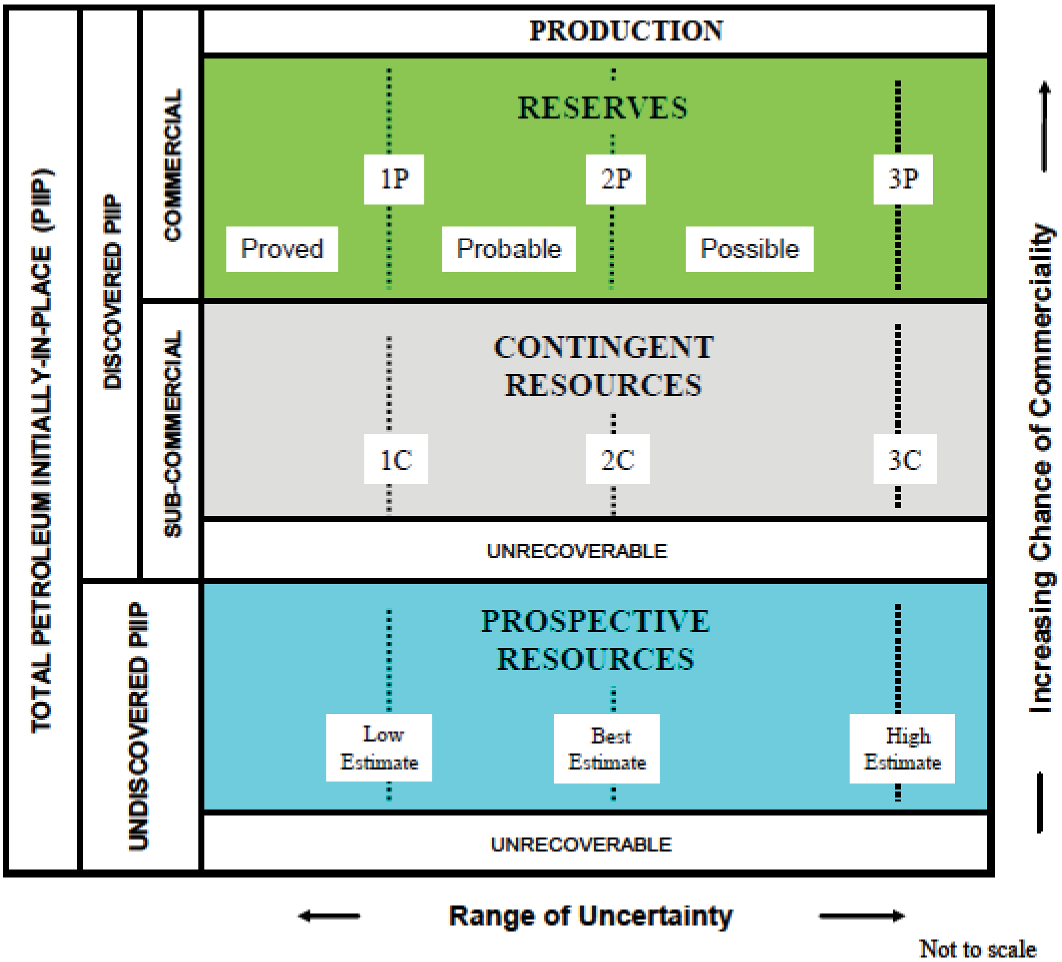
Even if increased mandatory disclosure does benefit researchers, this is unlikely to tip the scale in considering the overall net social value of increased mandatory disclosure. While most research suggests that, assuming production and proprietary costs are negligible, increased mandatory disclosure is not a net loss to society, other research recommends that regulators consider both the real effects cost of disclosure (Plantin *et al*., 2008; Goldstein and Sapra, 2012) and the role of signalling effects (Ferguson *et al*., 2013) when limiting managers' disclosure choices.

Following the literature on agency risk, earnings management, auditing, and corporate governance, future research might examine the role of agency risk in motivating 'resource estimate management,' and the ability of corporate governance and market-based discipline to restrain such behaviour. Related to this, but independent of reserve estimates, future research might examine the practice of managing earnings by processing more high (low) grade ore during the financial period to increase (decrease)

[117] ASX Listing Rules Review, 2011, Issues Paper, Issue 4; JORC Code Review, 2011, Issues Paper, Issue 5

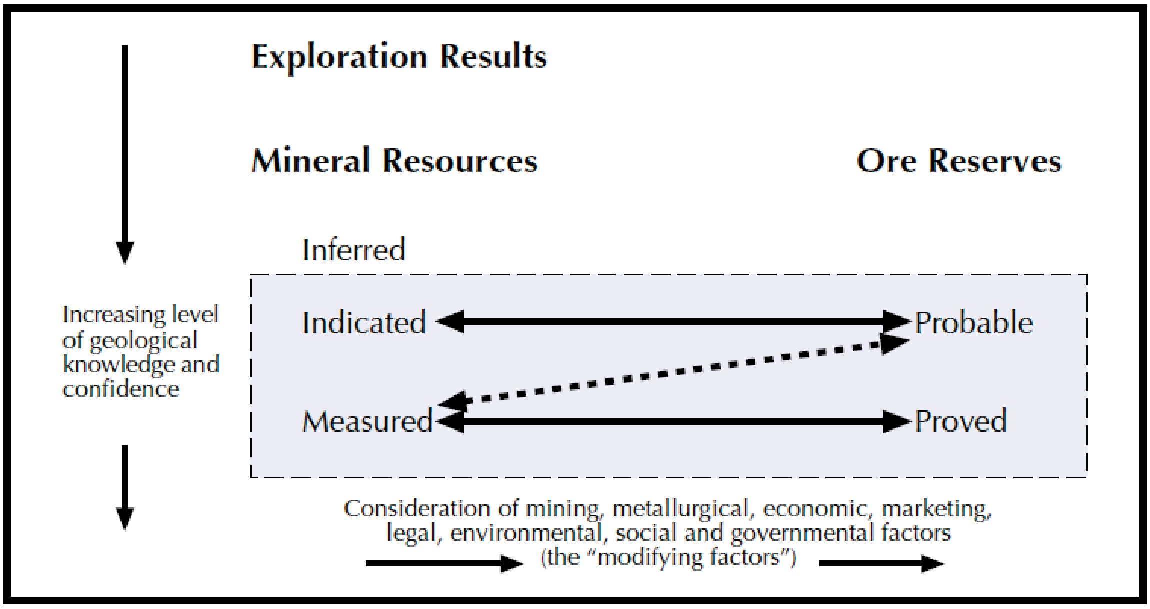
gross profit, as well as the ability for the capital markets to utilise reserve estimates in deconstructing earnings management.

Figure 1: Resources Classification Framework – Petroleum.



Petroleum Resource Management System (2007), page 2 (figure 1-1).

Figure 2: General Relationship between Exploration Results, Mineral Resources, and Ore Reserves.



Joint Ores Reserves Committee code (2004), page 6 (figure 1).

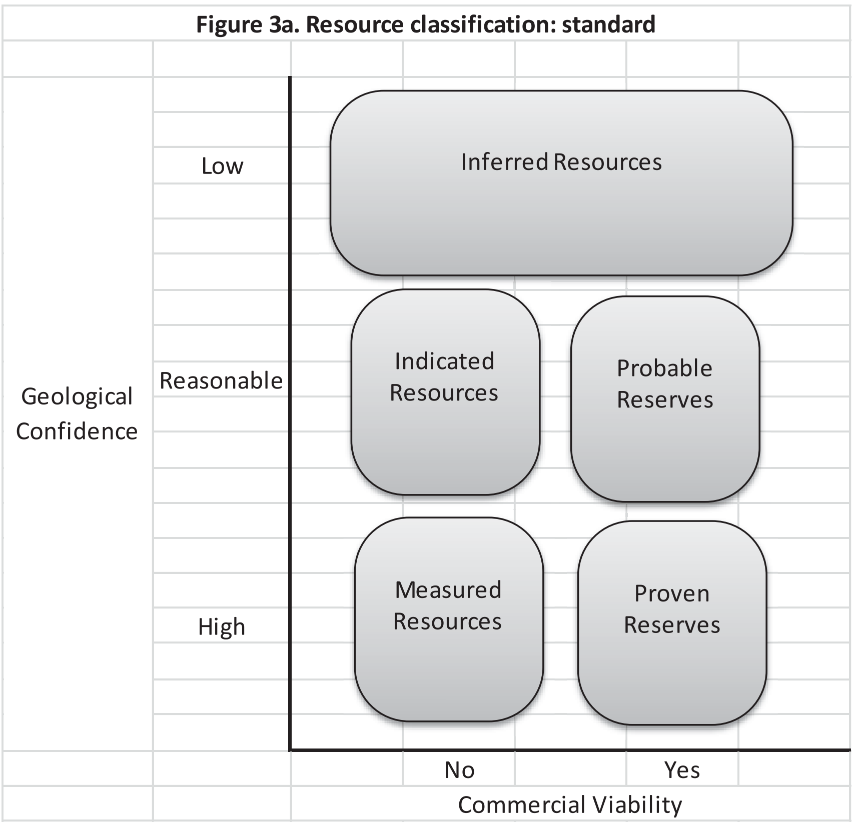


Figure 3b. Resource classification: SEC Industry Guide 7

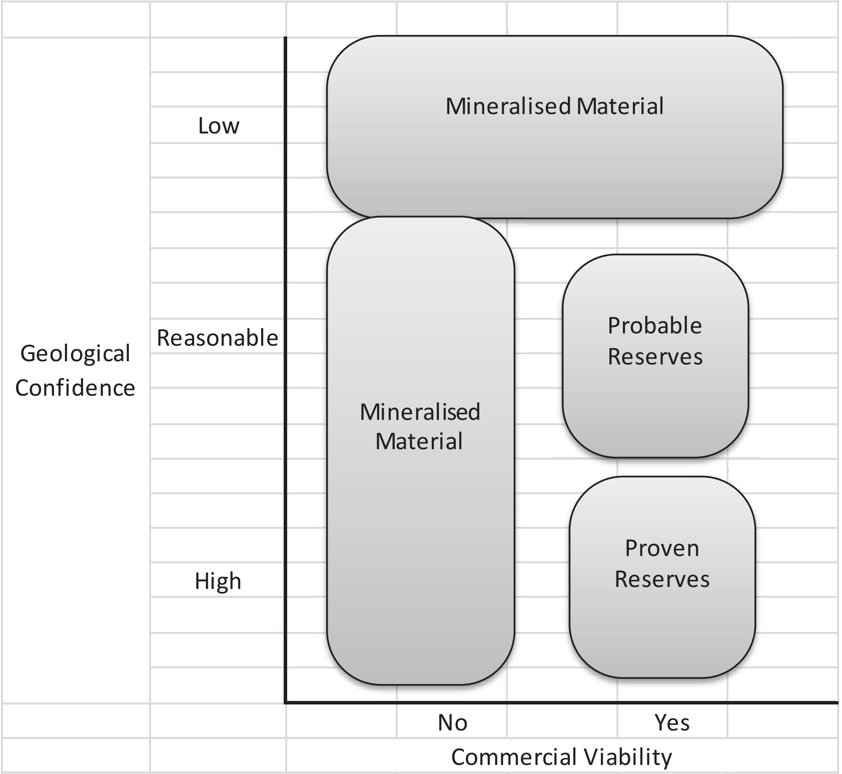
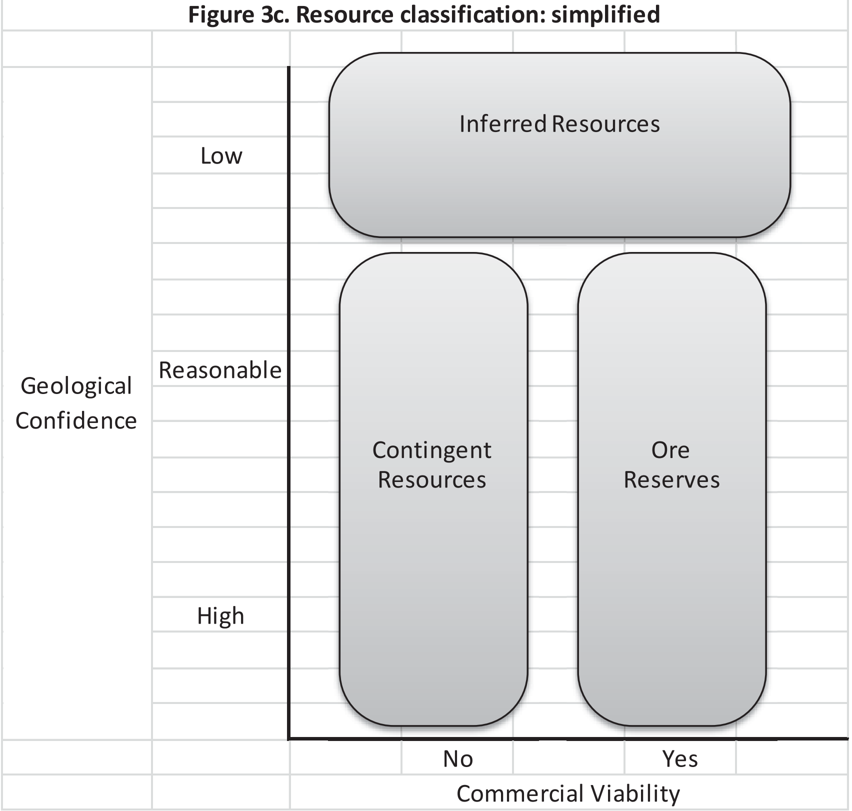
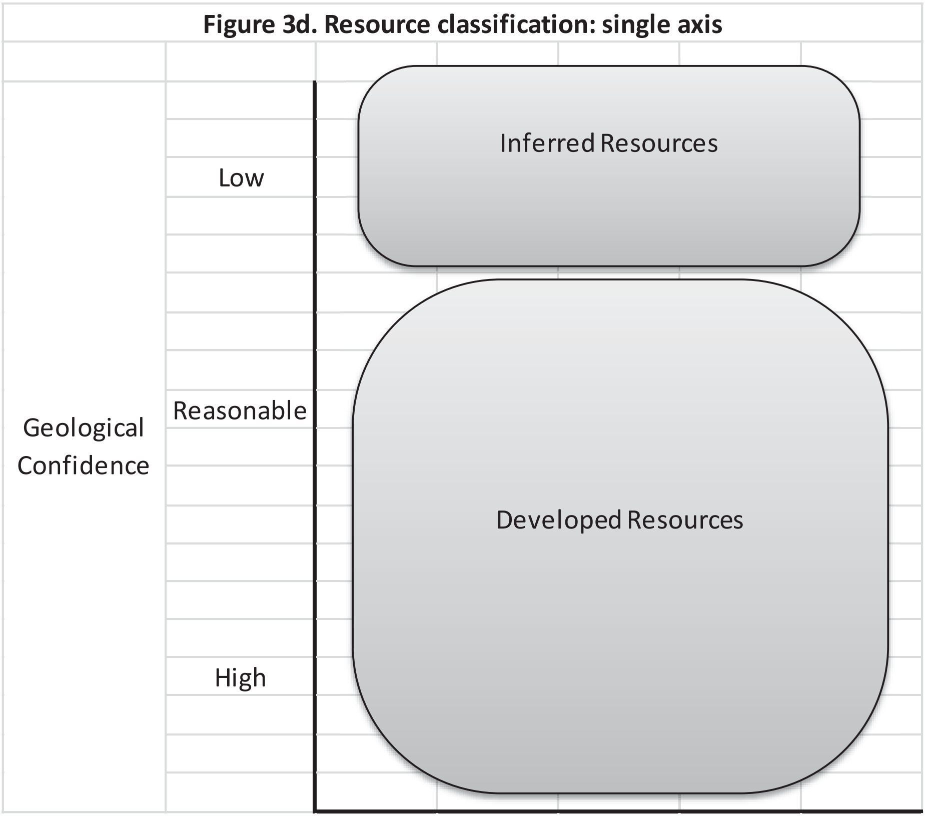
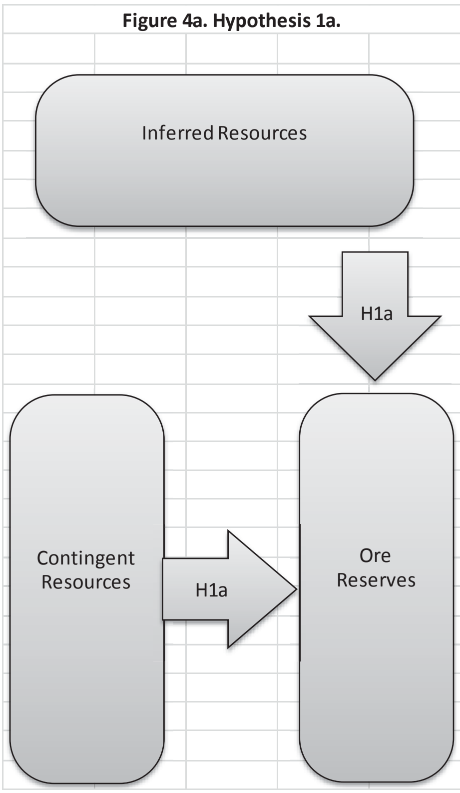


Figure 3c. Resource classification: simplified

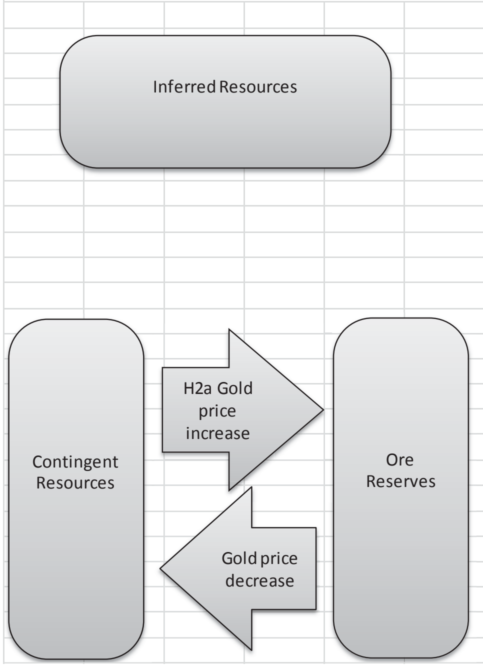






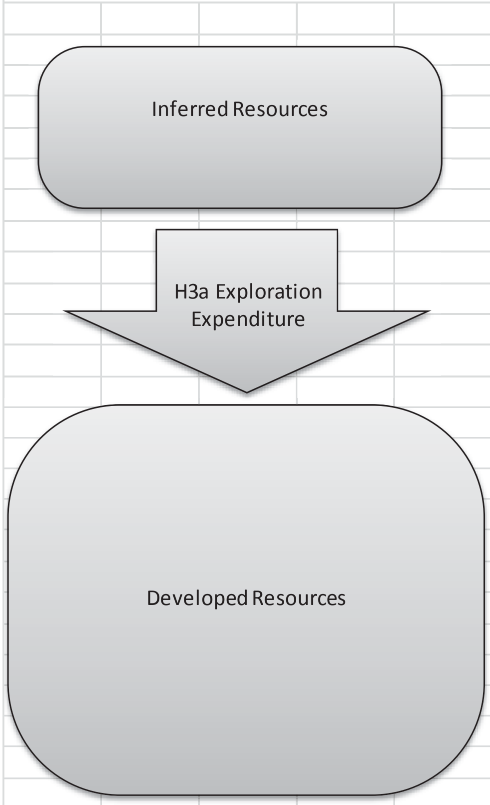
H_{1a}: Estimates of contingent resources and estimates of inferred resources are positively associated with the future change in reserve estimates.

Figure 4b. Hypothesis 2a.

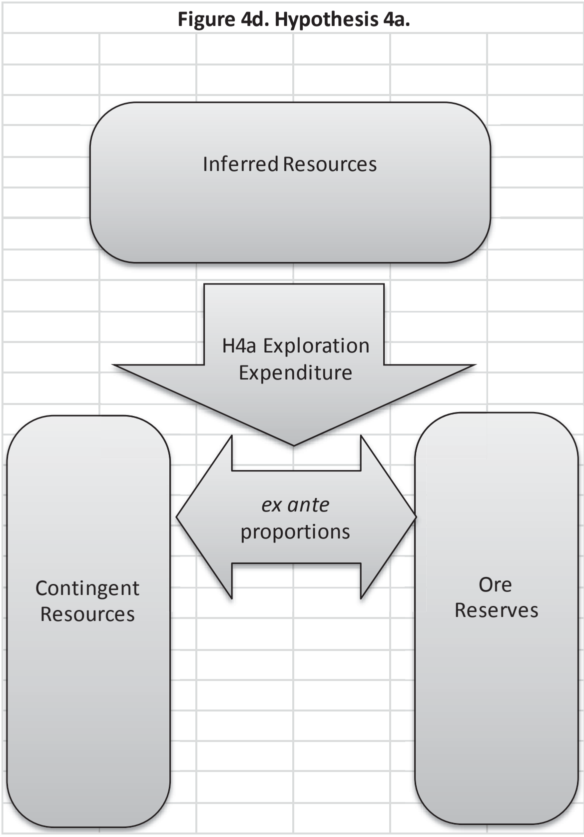


H_{2a}: The association between estimates of contingent resources and future change in estimates of reserves is conditional upon future increases in the gold price.

Figure 4c. Hypothesis 3a.



H_{3a}: The association between estimates of inferred resources and future change in estimates of developed resources is conditional upon future exploration expenditure.



H_{4a}: The association between current estimates of inferred resources and future change in estimates of reserves is conditional upon the current proportion of developed resources that are reserves.

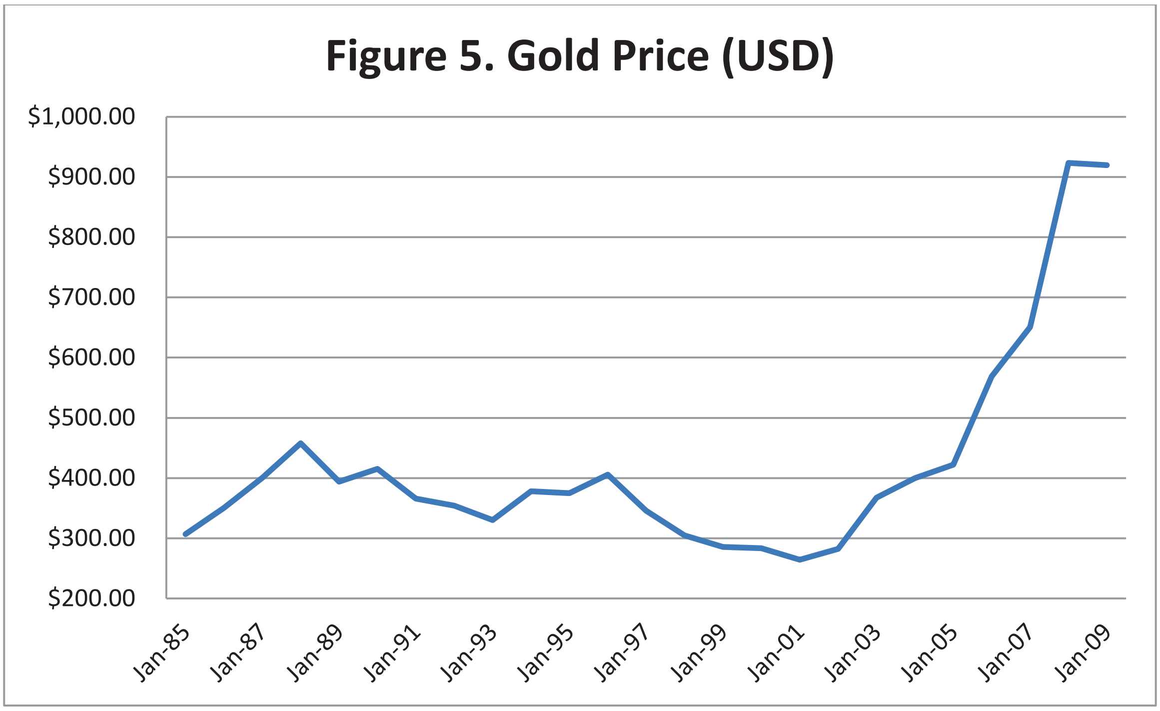


Table 1 Balance sheet with different levels of development, capitalisation and amortisation.

Project development	0%	50%	50%	100%	100%	100%	100%
Capitalisation	N/A	0%	100%	0%	100%	100%	100%
Amortisation	N/A	N/A	0%	N/A	0%	50%	100%
Past capital expenditure	-	$ 500,000	$ 500,000	$ 1,000,000	$ 1,000,000	$ 1,000,000	$ 1,000,000
ASSETS							
Net working capital (incl. cash)	$ 1,800,000	$ 1,300,000	$ 1,300,000	$ 800,000	$ 800,000	$ 800,000	$ 800,000
Capitalised mining assets*							
Gross	-	-	$ 500,000	-	$ 1,000,000	$ 1,000,000	$ 1,000,000
Accumulated amortisation	-	-	-	-	-	$ 500,000	$ 1,000,000
Net	-	-	$ 500,000	-	$ 1,000,000	$ 500,000	-
TOTAL ASSETS	$ 1,800,000	$ 1,300,000	$ 1,800,000	$ 800,000	$ 1,800,000	$ 1,300,000	$ 800,000
OBLIGATIONS							
Share capital	$ 1,500,000	$ 1,500,000	$ 1,500,000	$ 1,500,000	$ 1,500,000	$ 1,500,000	$ 1,500,000
Retained profits/accumulated losses	-	-$ 500,000	-	-$ 1,000,000	-	-$ 500,000	-$ 1,000,000
TOTAL EQUITY	$ 1,500,000	$ 1,000,000	$ 1,500,000	**$ 500,000**	$ 1,500,000	$ 1,000,000	**$ 500,000**
DEBT	$ 300,000	$ 300,000	$ 300,000	$ 300,000	$ 300,000	$ 300,000	$ 300,000
TOTAL OBLIGATIONS	$ 1,800,000	$ 1,300,000	$ 1,800,000	$ 800,000	$ 1,800,000	$ 1,300,000	$ 800,000
Future capital expenditure	$ 1,000,000	$ 500,000	$ 500,000	-	-	-	-
Net working capital - Debt	$ 1,500,000	$ 1,000,000	$ 1,000,000	$ 500,000	$ 500,000	$ 500,000	$ 500,000
Total equity - Net mining assets	$ 1,500,000	$ 1,000,000	$ 1,000,000	$ 500,000	$ 500,000	$ 500,000	$ 500,000
Total assets - Capital expenditure	$ 800,000	$ 800,000	$ 1,300,000	$ 800,000	$ 1,800,000	$ 1,300,000	$ 800,000
Total obligations - Capital expenditure	$ 800,000	$ 800,000	$ 1,300,000	$ 800,000	$ 1,800,000	$ 1,300,000	$ 800,000
Net working capital - Debt - Future capital expenditure	$ 500,000	$ 500,000	$ 500,000	$ 500,000	$ 500,000	$ 500,000	$ 500,000
Total equity - Net mining assets - Future capital expenditure	**$ 500,000**	**$ 500,000**	**$ 500,000**	**$ 500,000**	**$ 500,000**	**$ 500,000**	**$ 500,000**

* Deferred exploration, deferred development, property acquisition, brought-forward rehabilitation.

Table 2: Resource and reserve estimate disclosure.

Summary of Southern Ashanti Gold Project Mineral Resource Estimate @ 0.8 g/t Au COG

Deposit	Category	Tonnage (Mt)	Grade Au (g/t)	Contained Ounces Au
Combined Salman and Anwia-Bokaso	Measured	18.6	1.84	1,100,000
Combined Salman and Anwia-Bokaso	Indicated	9.84	1.67	530,000
Total Southern Ashanti Gold Project	**Measured & Indicated**	**28.4**	**1.78**	**1,630,000**
and...	**Inferred**	**6.43**	**1.64**	**340,000**

Note: For details on the key assumptions, parameters and methods used to estimate the mineral resource please refer to the Mineral Resource Update, announcement of 19 February 2008, Technical Report dated 21 August 2008 and Material Change Report dated 5 March 2008, all of which are filed on SEDAR.

Summary of Southern Ashanti Gold Project Ore Reserve Estimate

Category	Tonnage (Mt)	Grade Au (g/t)	Contained Ounces Au ('000)
Proven Ore	10.12	2.08	678
Probable Ore	1.9	2.24	137
Total Ore	**12.02**	**2.11**	**815**

Note: For full details on the key assumptions, parameters and methods used to estimate the ore reserve, please refer to the Company's Ore Reserve Update announcement of 2 April 2008, Technical Report dated 21 August 2008 and Material Change Report dated 9 April 2008, all of which are filed on SEDAR.

Adamus Resources Ltd 2008 annual report, page 5.

Table 3: Feasibility study.

Estimated Capital and Operating Costs

Total Capital Costs - includes contingency	**US$87 million US$8 million**
Cash Operating Costs Years 1-2	**~ US$350 per ounce**
Cash Operating Costs Life of Mine	**~ US$450 per ounce**

Production Scenario

Estimated Production Life of Mine	**12 million tonnes**
Annual Production Level	**1.3 million tonnes 100,000 ounces**
Expected Production Start	**18-24 months from construction, targeted 2010**

Adamus Resources Ltd 2008 annual report, page 6.

Table 4: Sensitivity analysis of the assumed gold price implicit in the reserve estimate.

Gold Price US$/oz	Physicals: Ore Total Tonnes	Au g/t	Waste Tonnes	Total Tonnes	W/O Ratio t/t	Contn'd Ounces koz	Recv'd Ounces koz	Recv. %	Economics: Mining Cost $'000	Th'put Cost $'000	Reven. $'000	Undisc'd C'Flow $'000	Mining Cost $/t	Th'put Cost $/t	Unit Cost $/oz	Unit Cost $/t Ore	NPV Analysis: Best Case $'000	Worst Case $'000	Avg. Case $'000
600	6,107,153	2.69	23,845,603	29,952,756	3.90	528,062	468,110	88.6%	62,455	110,632	270,757	97,670	2.09	18.12	370	28.3	77,472	75,642	76,557
625	6,779,506	2.62	26,747,739	33,527,245	3.95	570,312	504,599	88.5%	69,994	123,396	304,023	110,633	4.03	18.20	383	28.5	86,454	83,403	84,928
650	7,359,562	2.55	29,021,815	36,381,377	3.94	604,173	532,791	88.2%	75,958	134,233	333,852	123,661	4.03	18.24	395	28.6	95,948	92,131	94,040
675	7,555,870	2.53	29,548,359	37,104,229	3.91	614,231	540,154	87.9%	77,302	137,523	351,470	136,645	4.03	18.20	398	28.4	105,593	101,427	103,510
700	7,970,551	2.47	30,056,227	38,026,778	3.77	632,524	555,302	87.8%	79,437	145,254	374,713	150,022	4.04	18.22	405	28.2	115,331	110,251	112,791
725	8,406,972	2.41	30,676,487	39,083,459	3.65	652,357	570,026	87.4%	81,409	153,175	398,389	163,805	4.04	18.22	412	27.9	125,465	119,543	122,504
750	9,040,235	2.40	36,650,517	45,690,752	4.05	697,178	609,020	87.4%	96,007	165,001	440,320	179,312	4.06	18.25	429	28.9	136,413	128,454	132,433
775	9,648,986	2.38	41,435,466	51,084,452	4.29	737,230	643,132	87.2%	108,597	176,766	480,488	195,125	4.08	18.32	444	29.6	147,417	137,695	142,556
800	10,461,298	2.31	43,169,792	53,631,090	4.13	778,219	669,739	86.1%	113,763	191,605	516,510	211,142	4.11	18.32	456	29.2	157,754	147,317	152,535
825	10,553,402	2.30	43,077,688	53,631,090	4.08	781,479	671,733	86.0%	113,763	193,170	534,220	227,287	4.11	18.30	457	29.1	169,104	158,403	163,753
850	10,834,897	2.29	44,631,025	55,465,922	4.12	798,948	682,939	85.5%	117,534	198,139	559,593	243,920	4.12	18.29	462	29.1	180,725	169,408	175,067
875	11,079,991	2.27	44,968,197	56,048,188	4.06	808,500	690,664	85.4%	118,909	203,038	582,572	260,625	4.12	18.32	466	29.1	191,694	179,732	185,713
900	11,251,780	2.25	45,024,593	56,276,373	4.00	814,000	694,820	85.4%	119,438	205,952	602,826	277,436	4.12	18.30	468	28.9	203,226	190,563	196,895

Adamus Resources Ltd technical report 21/08/08, page 226 (table 18-6).

Table 5: Reserve reconciliation.

Reconciliation of Proven and Probable Mineral Reserves - December 31, 2007 to December 31, 2008

Reconciliation	Tonnes (millions)	Contained Ounces (millions)	Tonnes (% of Opening)	Ounces (% of Opening)
Opening Mineral Reserves at December 31, 2007	62.3	4.93	100	100
Gold Price Increase(1)	31.2	1.54	50	31
Exploration Changes(2)	(1.0)	(0.10)	(2)	(2)
Mining Depletion(3)	(5.5)	(0.39)	(9)	(8)
Engineering (4)	(51.5)	(2.70)	(83)	(55)
Closing Mineral Reserves at December 31, 2008 (5)	35.5	3.28	57	67

Notes to the reconciliation of Mineral Reserves:

(1) Gold Price Increase represents changes resulting from an increase in gold price used in the Mineral Reserve estimates from $560 per ounce in 2007 to $700 per ounce in 2008.

(2) Exploration Changes include changes due to geological modeling, data interpretation and resource block modeling methodology as well as due to exploration discovery of new mineralization.

(3) Mining Depletion represents 2007 Mineral Reserve mined and processed in 2008 before considering recovery losses and therefore does not correspond with 2008 actual gold production.

(4) Engineering includes changes as a result of engineering facts such as changes in operating costs, mining dilution and recovery assumptions, metallurgical recoveries, pit slope angles and other mine design and permitting considerations.

(5) Numbers may not add due to rounding.

Golden Star Resources Ltd. 2008 10-K annual report, page 15.

Table 6: Production information.

Operating Statistics	Units	2002-2003 YTD
Total Mine Production		
Ore Mined	Tonnes	261,854
Ore Grade	G/t Au	5.85
Low Grade Stock Drawn		
Ore Tonnes	Tonnes	170,943
Ore Grade	G/t Au	0.80
Total Ore Processed		
Ore Tonnes	Tonnes	439,574
Ore Grade	G/t Au	3.80
Met. Recovery	%	94.1%
Gold Produced	Oz	50,567
Gold Poured	Oz	50,678
Production Cost Statement		
Net Cash Costs	$/oz	429
Inventory Movements	$/oz	(1)
Cash Operating Cost	$/oz	428
Depreciation/Amortisation	$/oz	102
Total Production Cost	$/oz	530
Abnormal Amortisation*	$/oz	107
Total Production Cost	$/oz	637

* a one-off write down of $5.4 million to the carrying value of mine properties and extensional exploration taken at year-end.

Abelle Limited 2003 Annual Report, page 15.

Table 7: Reconciliation of Cost of Sales to Total Cash Costs.

Reconciliation of Cost of Sales to Total Cash Costs per Ounce/Pound

($ millions, except per ounce/pound information in dollars)	Gold			Copper		
For the years ended December 31	**2008**	2007	2006	**2008**	2007	2006
Cost of sales	**$ 3,426**	$ 2,805	$ 2,319	**$ 436**	$ 339	$ 391
Cost of sales attributable to discontinued operations	**–**	(9)	51	**–**	–	–
Cost of sales attributable to non-controlling interests[1]	**(14)**	(15)	(12)	**–**	–	–
Unrealized non-hedge gains/(losses) on currency and commodity contracts	**(15)**	(5)	–	**–**	–	–
Inventory purchase accounting adjustments	**(16)**	–	(11)	**–**	(9)	(97)
Impact of Barrick Energy	**(14)**	–	–	**–**	–	–
Total cash costs	**3,367**	2,776	2,347	**436**	330	294
Ounces/pounds sold – consolidated basis (000s)	**7,658**	8,108	8,566	**367**	401	376
Ounces/pounds sold – non-controlling interest (000s)	**(63)**	(53)	(176)	**–**	–	–
Ounces/pounds sold – equity basis (000s)	**7,595**	8,055	8,390	**367**	401	376
Total cash costs per ounce/per pound	**$ 443**	$ 345	$ 280	**$ 1.19**	$ 0.82	$ 0.78

Barrick Gold Corporation 2008 Annual Report, page 74.

Table 8. A comparison of different resource reporting codes.

	JORC (since 1989)	NPS 2-A (1983 to 2001)	CIM / NI 43-101 (since 2001)	SEC Industry Guide 7 (since 1981)
Ore Reserves	Required	Allowed	Required	Allowed
Feasibility reports	Not required	Not required	Required for Reserves	Required for Reserves
Possible Reserves	Forbidden	Allowed	Forbidden	Forbidden
Contingent Resources	Required	Allowed	Required	Limited to 'Mineralised material'
Inferred Resources	Required	Allowed	Required	Forbidden by informal guidance
Technical Reports	Not required	Not required	Required for Resources	Not required

Table 9A Sample selection.

	Firms	Firm-years
Firms in the gold mining industry, listed on ASX, Amex, NASDAQ, NYSE, TSX or TSXV during 1995-2008:	2,187	19,945
--Firms with tickers beginning with A-D:	528	4,816
--Explorers with no resource estimates		2,995
--Explorers disclosing resources but not reserves		1,113
--Non-disclosing producers		51
--Firms disclosing gold reserves	118	**657**
--Firms missing pricing data		87
--Small firms* and non-gold firms**		195
--Firms with available pricing data	76	**375**

* Less than 100,000 ounces of reserves

** Less than 33% of reserve value is gold

Table 9B Comparison of market capitalisation (in USD) for sub-samples with tickers A-D and E-Z for total mining industry.

	Count	Mean	Median
Australian firm-years			
A-D	1,647	$ 983,770,564	$ 10,774,132
E-Z	3,691	$ 370,031,615	$ 11,437,024
Student t-stat / Mann-Whitney U-stat		2.737	3,010,242
p-value		0.006	0.573
Australian firms (mean across years)			
A-D	234	$ 602,885,947	$ 17,163,179
E-Z	538	$ 262,419,424	$ 17,849,936
Student t-stat / Mann-Whitney U-stat		1.061	62,565
p-value		0.290	0.894
North American firm-years			
A-D	1,486	$ 104,470,673	$ 13,034,000
E-Z	3,836	$ 310,220,184	$ 15,213,500
Student t-stat / Mann-Whitney U-stat		6.511	2,731,136
p-value		0.000	0.018
North American firms (mean across years)			
A-D	330	$ 72,994,724	$ 13,859,429
E-Z	888	$ 188,538,394	$ 13,374,250
Student t-stat / Mann-Whitney U-stat		3.075	142,723
p-value		0.002	0.486

p-values are two-tailed.

Table 10 Sample composition by year and reporting code.

		NPS 2-A & NI 43-101 (Canada)	JORC (Australia)	SEC (USA)	Total
By Year	1995	9	21	9	39
	1996	19	23	7	49
	1997	22	27	9	58
	1998	21	25	8	54
	1999	22	22	6	50
	2000	20	19	5	44
	2001	20	19	5	44
	2002	23	18	4	45
	2003	22	17	5	44
	2004	26	19	4	49
	2005	27	17	3	47
	2006	27	16	3	46
	2007	27	15	2	44
	2008	28	14	2	44
	Total	313	272	72	657

NI 43-101 includes some cross-listed USA-based firms

Table 11A Descriptive statistics of dependent and independent variables.							
		Obs.	Mean	Std. Dev.	Min.	Median	Max.
Reserves and	T=0	657	0.040	0.234	0.000	0.005	3.369
change in reserves	T=1 - T=0	555	0.003	0.022	-0.089	0.000	0.460
per share	T=2 - T=0	464	0.009	0.039	-0.068	0.001	0.513
(after T years)	T=3 - T=0	389	0.012	0.038	-0.054	0.001	0.446
	T=4 - T=0	319	0.016	0.040	-0.052	0.002	0.446
	T=5 - T=0	257	0.021	0.048	-0.055	0.002	0.446
	T=6 - T=0	207	0.027	0.059	-0.047	0.003	0.446
	T=7 - T=0	164	0.035	0.072	-0.049	0.003	0.446
	T=8 - T=0	133	0.043	0.087	-0.041	0.004	0.446
	T=9 - T=0	104	0.048	0.093	-0.038	0.004	0.357
	T=10 - T=0	77	0.059	0.110	-0.027	0.007	0.389
Developed Resc.	T=0	585	0.027	0.060	0.000	0.008	0.669
and change	T=1 - T=0	493	0.004	0.014	-0.083	0.000	0.113
per share	T=2 - T=0	410	0.009	0.024	-0.072	0.001	0.158
(after T years)	T=3 - T=0	344	0.015	0.034	-0.102	0.002	0.189
	T=4 - T=0	282	0.021	0.045	-0.096	0.004	0.238
	T=5 - T=0	226	0.028	0.055	-0.087	0.005	0.248
	T=6 - T=0	182	0.037	0.069	-0.073	0.007	0.318
	T=7 - T=0	144	0.048	0.085	-0.031	0.007	0.384
	T=8 - T=0	117	0.058	0.104	-0.011	0.008	0.477
	T=9 - T=0	93	0.067	0.121	-0.010	0.007	0.522
	T=10 - T=0	70	0.082	0.143	-0.008	0.009	0.555
Exploration	T=0	657	0.084	0.303	0.000	0.009	4.003
(after T years)	T=1	555	0.115	0.555	0.000	0.011	10.443
	T=2	464	0.272	1.316	0.000	0.026	22.620
	T=3	389	0.385	1.399	0.000	0.039	16.168
	T=4	319	0.539	2.075	0.000	0.050	24.683
	T=5	257	0.593	2.166	0.000	0.066	25.459
	T=6	207	0.545	1.378	0.000	0.082	15.379
	T=7	164	0.590	1.130	0.000	0.091	6.724
	T=8	133	0.725	1.347	0.000	0.106	7.985
	T=9	104	0.933	1.708	0.002	0.118	8.234
	T=10	77	1.204	2.342	0.002	0.138	9.788

All Resources variables are ounces per share. Future Reserves include concurrent extraction (undeflated by recovery rates). Reserves represent the commercially-viable portion of Resources (Resc.). Contingent represents the commercially-unviable portion of Resources. Inferred represents the untestable portion of Resources. Mineralised Material (Min. Mat.) is Contingent plus Inferred. Developed Resources are Reserves plus Contingent. Exploration is the sum of future expenditure on exploration (USD, deflated by Current Reserves).

Table 11B Descriptive statistics of dependent and independent variables (cont.).

		Obs.	Mean	Std. Dev.	Min.	Median	Max.
Acquisitions	T=1	555	5%	33%	-80%	0%	500%
(after T years)	T=2	464	6%	38%	-80%	0%	500%
	T=3	389	6%	40%	-100%	0%	500%
	T=4	319	6%	43%	-100%	0%	500%
	T=5	257	5%	44%	-100%	0%	500%
	T=6	207	4%	40%	-100%	0%	500%
	T=7	164	3%	43%	-100%	0%	600%
	T=8	133	2%	41%	-100%	0%	600%
	T=9	104	2%	43%	-100%	0%	700%
	T=10	77	2%	42%	-100%	0%	700%
(in year T=0)	Resources	657	0.097	0.586	0.000	0.020	7.603
	Min. Mat.	657	0.057	0.358	0.000	0.010	4.809
	Resv. / Resc.	657	40.5%	27.8%	0.1%	35.9%	100.0%
	Devpr	657	29.7%				
	Contingent	585	0.008	0.017	0.000	0.002	0.137
	Inferred	585	0.013	0.022	0.000	0.004	0.140
	Inf. / Min. Mat.	544	58.4%	31.6%	0.0%	56.9%	100.0%
	Prod.	462	16.8%	15.0%	0.0%	13.5%	95.0%
	MVE	375	3.459	7.848	0.008	0.653	75.226
	SResc.	375	48.341	219.916	0.225	11.854	2305.206
	SResv.	375	20.845	87.214	0.054	4.237	879.213
	SMin.Mat.	375	27.497	135.002	0.000	5.820	1531.698
	SBypr.	375	7.956	34.139	0.000	0.000	407.547
	BVEa	375	3.515	18.985	-0.928	0.458	299.076
	Sunk	375	3.556	19.728	0.000	0.432	260.870
	CapEx.	375	0.756	4.424	0.000	0.000	47.051
	Resv. / Dev.	321	0.658	0.246	0.080	0.681	1.000
	SCon.	321	4.626	8.365	0.000	1.455	69.997
	SInf.	321	6.368	8.777	0.000	2.700	44.589

Acquisitions is the percentage future change in the number of projects disclosing resources. Resource estimate variables are ounces per share, or multiplied by the USD spot price (S).. Reserves (Resv.) represent the commercially-viable portion of Resources (Resc.). Contingent (Con.) represents the commercially-unviable portion of Resources. Inferred (Inf.) represents the untestable portion of Resources. Mineralised Material (Min. Mat.) is Contingent plus Inferred. Developed Resources are Reserves plus Contingent. Devpr is an indictor variable for firms with zero current production. Prod is the amount of current production ounces deflated by the sum of current production and reserves. All dollar value variables are in USD. Market value of equity (MVE) is the stock price six months after the financial year end. BVEa is the book value of ordinary equity minus Sunk and CapEx. Sunk is the book value of property, plant and equipment, and intangible assets. CapEx is the expected future expenditure on Sunk (from the feasibility report).

Table 12A Correlation matrix of independent variables.

	SReserves	*SContingent*	*SInferred*	*SByproducts*	*BVEa*	*Sunk*	*CapEx.*
SReserves	.	0.736***	0.530***	0.792***	0.654***	0.588***	0.580***
SContingent	0.498***	.	0.546***	0.574***	0.545***	0.501***	0.345***
SInferred	0.567***	0.425***	.	0.394***	0.492***	0.458***	0.192***
SByproducts	0.380***	0.308***	0.360***	.	0.349***	0.343***	0.800***
BVEa	0.748***	0.347***	0.655***	0.430***	.	0.968***	-0.025
Sunk	0.711***	0.300***	0.592***	0.373***	0.876***	.	-0.031
CapEx.	0.009	0.074	-0.080	-0.068	-0.242***	-0.449***	.

Pearson Parametric above diagonal, Spearman Non-parametric below

*** *p*-value < .01; ** *p*-value < .05; * *p*-value < .10

Resource estimate variables are ounces per share multiplied by the USD spot price (S).. Reserves represent the commercially-viable portion of Resources. Contingent represents the commercially-unviable portion of Resources. Inferred represents the untestable portion of Resources. All dollar value variables are in USD. BVEa is the book value of ordinary equity minus Sunk and CapEx. Sunk is the book value of property, plant and equipment, and intangible assets. CapEx is the expected future expenditure on Sunk (from the feasibility report).

Table 12B Correlation of exploration expenditure in year T=0 with T>0.

	T=1	T=2	T=3	T=4	T=5	T=6	T=7	T=8	T=9	T=10
Pearson Parametric	0.809***	0.787***	0.739***	0.633***	0.576***	0.526***	0.470***	0.425***	0.505***	0.568***
Spearman Non-parametric	0.843***	0.803***	0.771***	0.760***	0.739***	0.749***	0.775***	0.788***	0.777***	0.748***

*** *p*-value < .01; ** *p*-value < .05; * *p*-value < .10

Exploration is the sum of future expenditure on exploration over T years (USD, deflated by Current Reserves).

Table 13A: Future change in reserves (T years ahead) and current total resources decomposed into reserves and mineralised material (SEC firms included).

	Pred.	T=1	T=2	T=3	T=4	T=5	T=6	T=7	T=8	T=9	T=10
Intercept		0.001	0.002	0.006	0.007	0.011	0.015	0.022	0.022	0.032	0.036
t-test		(0.143)	(0.003)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(0.001)	(<0.001)	(<0.001)
Resv.	+	0.020	0.129	0.152	0.280	0.213	0.188	0.008	-0.023	-0.266	-0.651
t-test		(0.540)	(<0.001)	(<0.001)	(<0.001)	(0.075)	(0.147)	(0.961)	(0.935)	(0.380)	(0.090)
Min. Mat.	?	0.017	0.008	-0.019	-0.007	-0.012	-0.005	-0.011	0.216	0.094	0.334
t-test		(0.690)	(0.707)	(0.309)	(0.767)	(0.690)	(0.908)	(0.865)	(0.264)	(0.594)	(0.276)
Acq		-0.001	0.006	0.002	0.000	0.001	0.001	0.003	0.008	0.013	0.019
t-test		(0.543)	(0.121)	(0.536)	(0.925)	(0.899)	(0.853)	(0.575)	(0.305)	(0.183)	(0.108)
*Acq * Resv.*	+	0.096	0.487	0.619	0.579	0.824	1.265	1.506	1.324	1.577	1.873
t-test		(0.392)	(0.180)	(0.035)	(0.008)	(0.005)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Adj. R^2		0.183	0.622	0.492	0.324	0.407	0.503	0.582	0.468	0.566	0.534
F-test		(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Obs.		555	464	389	319	257	207	164	133	104	77

All Resources variables are ounces per share. Future Reserves (Resv.) include concurrent extraction (undeflated by recovery rates). Reserves represent the commercially-viable portion of Resources. Contingent represents the commercially-unviable portion of Resources. Inferred represents the untestable portion of Resources. Mineralised Material (Min. Mat.) is Contingent plus Inferred. Developed Resources are Reserves plus Contingent. Acq is the percentage future change in the number of projects disclosing resources. Regressions include adjustments for period fixed effects. t-tests utilise White's diagonal corrected errors. p-values are two-tailed.

$$Resv_{i,t+T} - Resv_{i,t} = \beta_0 + \beta_1 Resv_{i,t} + \beta_2 MinMat_{i,t} + \beta_3 Acq_{i,t+T} + \beta_4 Acq_{i,t+T} * Resv_{i,t} + \varepsilon_{i,t+T}$$

Table 13B: Future change in reserves (T years ahead) and current total resources decomposed into reserves and mineralised material (SEC firms excluded).

	Pred.	T=1	T=2	T=3	T=4	T=5	T=6	T=7	T=8	T=9	T=10
Intercept		0.001	0.002	0.002	0.003	0.006	0.008	0.011	0.014	0.018	0.020
t-test		(0.121)	(0.038)	(0.073)	(0.016)	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)	(0.011)
Resv.	+	0.008	0.076	0.369	0.444	0.442	0.503	0.548	0.720	0.982	1.306
t-test		(0.773)	(0.265)	(<0.001)	(0.001)	(0.012)	(<0.001)	(0.002)	(0.001)	(0.003)	(0.039)
Min. Mat.	?	0.061	0.091	0.096	0.127	0.156	0.188	0.222	0.254	0.227	0.311
t-test		(0.134)	(0.090)	(0.048)	(0.082)	(0.100)	(0.033)	(0.104)	(0.191)	(0.319)	(0.339)
Acq		0.000	0.002	0.002	0.000	0.003	0.004	0.008	0.012	0.020	0.028
t-test		(0.780)	(0.668)	(0.487)	(0.903)	(0.383)	(0.155)	(0.101)	(0.131)	(0.054)	(0.032)
*Acq * Resv.*	+	0.105	0.239	0.194	0.277	0.457	0.858	0.939	0.905	0.865	0.735
t-test		(0.504)	(0.207)	(0.240)	(0.056)	(0.015)	(<0.001)	(<0.001)	(<0.001)	(0.002)	(0.116)
Adj. R^2		0.051	0.206	0.446	0.486	0.558	0.700	0.700	0.696	0.698	0.645
F-test		(0.003)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Obs.		493	410	344	282	226	182	144	117	93	70

All Resources variables are ounces per share. Future Reserves (Resv.) include concurrent extraction (undeflated by recovery rates). Reserves represent the commercially-viable portion of Resources. Contingent represents the commercially-unviable portion of Resources. Inferred represents the untestable portion of Resources. Mineralised Material (Min. Mat.) is Contingent plus Inferred. Developed Resources are Reserves plus Contingent. Acq is the percentage future change in the number of projects disclosing resources. Regressions include adjustments for period fixed effects. t-tests utilise White's diagonal corrected errors. p-values are two-tailed.

$$Resv_{i,t+T} - Resv_{i,t} = \beta_0 + \beta_1 Resv_{i,t} + \beta_2 MinMat_{i,t} + \beta_3 Acq_{i,t+T} + \beta_4 Acq_{i,t+T} * Resv_{i,t} + \varepsilon_{i,t+T}$$

Table 13C: Future change in reserves (T years ahead) and current total resources decomposed into reserves, contingent and inferred.

	Pred.	T=1	T=2	T=3	T=4	T=5	T=6	T=7	T=8	T=9	T=10
Intercept		0.001	0.002	0.002	0.003	0.006	0.008	0.012	0.014	0.017	0.018
t-test		(0.079)	(0.026)	(0.089)	(0.024)	(0.003)	(0.001)	(0.001)	(0.003)	(0.003)	(0.032)
Resv.	+	-0.003	0.066	0.382	0.472	0.464	0.487	0.499	0.742	1.056	1.681
t-test		(0.929)	(0.352)	(<0.001)	(0.001)	(0.021)	(0.001)	(0.012)	(0.002)	(0.013)	(0.046)
Con.	+	0.146	0.163	0.027	0.006	0.083	0.222	0.310	0.217	0.114	-0.207
t-test		(0.030)	(0.078)	(0.783)	(0.964)	(0.672)	(0.142)	(0.154)	(0.440)	(0.765)	(0.727)
Inf.	+	0.018	0.053	0.131	0.189	0.192	0.174	0.191	0.269	0.268	0.445
t-test		(0.621)	(0.315)	(0.018)	(0.014)	(0.040)	(0.088)	(0.210)	(0.268)	(0.337)	(0.285)
Acq		0.000	0.002	0.002	0.000	0.003	0.004	0.008	0.012	0.020	0.028
t-test		(0.875)	(0.640)	(0.526)	(0.969)	(0.403)	(0.156)	(0.107)	(0.134)	(0.054)	(0.030)
*Acq * Resv.*	+	0.110	0.246	0.182	0.251	0.435	0.874	0.984	0.888	0.805	0.451
t-test		(0.477)	(0.195)	(0.273)	(0.091)	(0.033)	(<0.001)	(<0.001)	(<0.001)	(0.022)	(0.470)
Adj. R^2		0.067	0.210	0.447	0.490	0.557	0.698	0.698	0.693	0.695	0.645
F-test		(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Obs.		493	410	344	282	226	182	144	117	93	70
Con. = Inf.		(0.002)	(0.104)	(0.194)	(0.093)	(0.413)	(0.753)	(0.560)	(0.845)	(0.660)	(0.274)

All Resources variables are ounces per share. Future Reserves (Resv.) include concurrent extraction (undeflated by recovery rates). Reserves represent the commercially-viable portion of Resources. Contingent represents the commercially-unviable portion of Resources. Inferred represents the untestable portion of Resources. Mineralised Material (Min. Mat.) is Contingent plus Inferred. Developed Resources are Reserves plus Contingent. Acq is the percentage future change in the number of projects disclosing resources. Regressions include adjustments for period fixed effects. t-tests utilise White's diagonal corrected errors. p-values are two-tailed.

$$Resv_{i,t+T} - Resv_{i,t} = \beta_0 + \beta_1 Resv_{i,t} + \beta_2 Con_{i,t} + \beta_3 Inf_{i,t} + \beta_4 Acq_{i,t+T} + \beta_5 Acq_{i,t+T} * Resv_{i,t} + \varepsilon_{i,t+T}$$

Table 14: Market value and current total resources decomposed into reserves, contingent and inferred.

	Pred.	Panel i SEC, JORC & NI 43-101	Panel ii JORC & NI 43-101	Panel iii JORC & NI 43-101
Intercept		2.492	-0.427	-0.429
t-test		(<0.001)	(0.603)	(0.602)
SResv.	+	0.168	0.296	0.297
t-test		(0.013)	(<0.001)	(0.000)
SMin.Mat.	+	-0.055	-0.050	
t-test		(0.048)	(0.171)	
SCon.	+			-0.054
t-test				(0.406)
SInf.	+			-0.045
t-test				(0.274)
SBypr.	+	0.010	-0.104	-0.104
t-test		(0.739)	(0.008)	(0.008)
BVEa	+	0.225	1.884	1.883
t-test		(0.213)	(0.001)	(0.001)
Sunk	+	-0.220	1.395	1.390
t-test		(0.172)	(<0.001)	(0.000)
CapEx.	+	-0.172	2.001	1.981
t-test		(0.341)	(0.122)	(0.114)
Adj. R^2		0.763	0.902	0.902
F-test		(<0.001)	(<0.001)	(0.000)
Obs.		375	321	321
SResv. = SMin.Mat.		(<0.001)	(<0.001)	
SCon. = SInf.				(0.864)

All variables are in USD per share. All Resources variables are multiplied by the USD spot price (S). Market value of equity (MVE) is the stock price six months after the financial year end. Reserves (Resv.) represent the commercially-viable portion of Resources (Resc.). Contingent (Con.) represents the commercially-unviable portion of Resources. Inferred (Inf.) represents the untestable portion of Resources. Mineralised Material (Min.Mat.) is Contingent plus Inferred. Developed Resources are Reserves plus Contingent. Bypr. is commodities other than gold (total resources). BVEa is the book value of ordinary equity minus Sunk and CapEx. Sunk is the book value of property, plant and equipment, and intangible assets. CapEx is the expected future expenditure on Sunk (from the feasibility report). Regressions include adjustments for cross-sectional and period fixed effects. t-tests utilise White's diagonal corrected errors. p-values are two-tailed.

Panels i & ii: $MVE_{i,t} = \beta_0 + \beta_1 SResv_{i,t} + \beta_2 SMinMat_{i,t} + \beta_3 SBypr_{i,t} + \beta_4 BVEa_{i,t} + \beta_5 Sunk_{i,t} + \beta_6 CapEx_{i,t} + \varepsilon_{i,t}$

Panel iii: $MVE_{i,t} = \beta_0 + \beta_1 SResv_{i,t} + \beta_2 SCon_{i,t} + \beta_3 SInf_{i,t} + \beta_4 SBypr_{i,t} + \beta_5 BVEa_{i,t} + \beta_6 Sunk_{i,t} + \beta_7 CapEx_{i,t} + \varepsilon_{i,t}$

Table 15A: Future change in reserves (T years ahead) and decomposed current developed resources: including interactions with future change in gold price.

	Pred.	T=1	T=2	T=3	T=4	T=5	T=6	T=7	T=8	T=9	T=10
Intercept		0.001	0.002	0.003	0.005	0.006	0.007	0.010	0.015	0.015	0.012
t-test		(0.094)	(0.030)	(0.002)	(0.001)	(0.004)	(0.006)	(0.007)	(0.012)	(0.045)	(0.352)
GoldMove		0.002	0.003	-0.003	-0.002	0.000	0.001	0.001	-0.001	0.002	0.010
t-test		(0.350)	(0.348)	(0.073)	(0.309)	(0.919)	(0.658)	(0.792)	(0.864)	(0.685)	(0.414)
Resv.	+	0.005	0.092	0.340	0.418	0.443	0.783	0.886	1.193	1.678	2.201
t-test		(0.890)	(0.323)	(<0.001)	(0.003)	(0.053)	(<0.001)	(<0.001)	(<0.001)	(0.001)	(0.006)
*GoldMove*Resv.*	+	-0.061	-0.093	0.340	0.363	0.228	-0.367	-0.522	-0.474	-0.579	-0.477
t-test		(0.638)	(0.727)	(0.080)	(0.093)	(0.367)	(0.008)	(0.002)	(0.023)	(0.065)	(0.356)
Contingent	+	0.165	0.212	0.013	-0.034	-0.017	0.004	-0.072	-0.471	-0.633	-0.643
t-test		(0.014)	(0.016)	(0.888)	(0.786)	(0.922)	(0.977)	(0.710)	(0.054)	(0.102)	(0.355)
*GoldMove*Con.*	+	0.139	0.184	0.324	0.293	0.408	0.671	0.925	1.123	1.097	0.576
t-test		(0.759)	(0.614)	(0.166)	(0.203)	(0.073)	(0.001)	(0.001)	(<0.001)	(0.001)	(0.063)
Acq		0.000	0.002	0.003	0.003	0.004	0.007	0.010	0.017	0.023	0.033
t-test		(0.654)	(0.547)	(0.206)	(0.363)	(0.104)	(0.005)	(0.016)	(0.043)	(0.054)	(0.031)
*Acq * Resv.*	+	0.125	0.269	0.101	0.145	0.371	0.957	1.241	1.105	1.096	0.701
t-test		(0.408)	(0.162)	(0.577)	(0.333)	(0.039)	(<0.001)	(<0.001)	(<0.001)	(0.010)	(0.397)
Adj. R2		0.071	0.198	0.485	0.524	0.578	0.709	0.719	0.726	0.716	0.639
F-test		(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Obs.		493	410	344	282	226	182	144	117	93	70

All Resources variables are ounces per share. Future Reserves (Resv.) include concurrent extraction (undeflated by recovery rates). Reserves represent the commercially-viable portion of Resources. Contingent (Con.) represents the commercially-unviable portion of Resources. Inferred represents the untestable portion of Resources. Mineralised Material is Contingent plus Inferred. Developed Resources are Reserves plus Contingent. Acq is the percentage future change in the number of projects disclosing resources. GoldMove is the percentage future change in the spot price of gold (USD). Pos (Neg) Gold is the piece-wise positive (negative) decomposition of GoldMove. t-tests utilise White's diagonal corrected errors. p-values are two-tailed.

$$
\begin{aligned}
Resv_{i,t+T} - Resv_{i,t} \\
&= \beta_0 + \beta_1 GoldMove_{i,t+T} + \beta_2 Resv_{i,t} + \beta_3 GoldMove_{i,t+T} * Resv_{i,t} + \beta_4 Con_{i,t} + \beta_5 GoldMove_{i,t+T} * Con_{i,t} \\
&+ \beta_6 Acq_{i,t+T} + \beta_7 Acq_{i,t+T} * Resv_{i,t} + \varepsilon_{i,t+T}
\end{aligned}
$$

Table 15B: Future Change in reserves (T years ahead) and decomposed current developed resources: including interactions with future change in gold price - decomposed into positive and negative changes.

	Pred.	T=1	T=2	T=3	T=4	T=5	T=6	T=7	T=8	T=9	T=10
Intercept		0.001	0.000	0.003	0.003	0.003	0.007	0.014	0.016	0.015	0.012
t-test		(0.252)	(0.789)	(0.154)	(0.260)	(0.299)	(0.079)	(0.016)	(0.018)	(0.045)	(0.352)
Pos GoldMove		0.000	0.007	-0.003	0.000	0.003	0.001	-0.002	-0.002	0.002	0.010
t-test		(0.892)	(0.122)	(0.332)	(0.988)	(0.393)	(0.762)	(0.695)	(0.743)	(0.685)	(0.414)
Neg GoldMove		-0.002	-0.018	-0.006	-0.014	-0.021	0.006	0.084	0.001		
t-test		(0.901)	(0.087)	(0.520)	(0.292)	(0.248)	(0.777)	(0.165)	(0.995)		
Resv.	+	0.040	0.239	0.404	0.637	0.643	0.568	0.699	1.194	1.678	2.201
t-test		(0.411)	(0.027)	(0.006)	(0.001)	(0.003)	(0.001)	(0.001)	(<0.001)	(0.001)	(0.006)
*Pos Gold*Rsv*	0	-0.335	-0.451	0.217	0.074	0.020	-0.165	-0.371	-0.468	-0.579	-0.477
t-test		(0.071)	(0.127)	(0.425)	(0.793)	(0.940)	(0.351)	(0.019)	(0.026)	(0.065)	(0.356)
*Neg Gold*Rsv*	+	0.516	1.102	0.758	1.603	1.297	-3.275	-7.835	72.477		
t-test		(0.158)	(0.288)	(0.407)	(0.141)	(0.367)	(<0.001)	(0.001)	(0.017)		
Contingent	0	0.038	0.054	-0.231	-0.291	-0.168	0.074	-0.135	-0.496	-0.633	-0.643
t-test		(0.682)	(0.745)	(0.382)	(0.326)	(0.612)	(0.766)	(0.602)	(0.050)	(0.102)	(0.355)
*Pos Gold*Con*	+	1.287	0.768	0.832	0.700	0.593	0.562	0.933	1.139	1.097	0.576
t-test		(0.049)	(0.208)	(0.114)	(0.121)	(0.122)	(0.038)	(0.004)	(<0.001)	(0.001)	(0.063)
*Neg Gold*Con*	0	-1.267	-0.923	-1.132	-1.064	-0.332	2.072	2.229	-8.755		
t-test		(0.025)	(0.396)	(0.341)	(0.432)	(0.816)	(0.042)	(0.390)	(0.034)		

Table 15B: Future Change in reserves (T years ahead) and decomposed current developed resources: including interactions with future change in gold price - decomposed into positive and negative changes (cont.).

	Pred.	T=1	T=2	T=3	T=4	T=5	T=6	T=7	T=8	T=9	T=10
Acq		-0.001	0.003	0.003	0.003	0.004	0.007	0.011	0.018	0.023	0.033
t-test		(0.527)	(0.490)	(0.188)	(0.345)	(0.149)	(0.014)	(0.015)	(0.050)	(0.054)	(0.031)
*Acq * Resv.*	+	0.123	0.232	0.083	0.128	0.367	0.925	1.197	1.095	1.096	0.701
t-test		(0.416)	(0.215)	(0.646)	(0.377)	(0.037)	(<0.001)	(<0.001)	(<0.001)	(0.010)	(0.397)
Adj. R^2		0.091	0.220	0.487	0.529	0.578	0.717	0.725	0.721	0.716	0.639
F-test		(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(0.000)
Obs.		493	410	344	282	226	182	144	117	93	70
Pos = Neg Gold		(0.865)	(0.124)	(0.855)	(0.516)	(0.367)	(0.878)	(0.284)	(>0.999)		
*Pos = Neg Gold*Resv.*		(0.003)	(<0.001)	(0.299)	(0.025)	(0.089)	(0.010)	(0.026)	(0.594)		
*Pos = Neg Gold*Con.*		(0.001)	(0.055)	(0.057)	(0.155)	(0.471)	(0.294)	(0.729)	(0.677)		

All Resources variables are ounces per share. Future Reserves (Resv.) include concurrent extraction (undeflated by recovery rates). Reserves represent the economically-viable portion of Resources. Contingent (Con.) represents the economically-unviable portion of Resources. Inferred represents the untestable portion of Resources. Mineralised Material is Contingent plus Inferred. Developed Resources are Reserves plus Contingent. Acq is the percentage future change in the number of projects disclosing resources. GoldMove is the percentage future change in the spot price of gold (USD). Pos (Neg) Gold is the piece-wise positive (negative) decomposition of GoldMove. t-tests utilise White's diagonal corrected errors. p-values are two-tailed.

$$Resv_{i,t+T} - Resv_{i,t} = \beta_0 + \beta_1 PosGold_{i,t+T} + \beta_2 NegGold_{i,t+T} + \beta_3 Resv_{i,t} + \beta_4 PosGold_{i,t+T} * Resv_{i,t} + \beta_5 NegGold_{i,t+T} * Resv_{i,t} + \beta_6 Con_{i,t} + \beta_7 PosGold_{i,t+T} * Con_{i,t} + \beta_8 NegGold_{i,t+T} * Con_{i,t} + \beta_9 Acq_{i,t+T} + \beta_{10} Acq_{i,t+T} * Resv_{i,t} + \varepsilon_{i,t+T}$$

Table 15C: Future Change in reserves (T years ahead) and decomposed current total resources: including interactions with future change in gold price - decomposed into positive and negative changes.

	Pred.	T=1	T=2	T=3	T=4	T=5	T=6	T=7	T=8	T=9	T=10
Intercept		0.001	-0.001	0.003	0.002	0.001	0.002	0.004	0.005	0.006	-0.001
t-test		(0.371)	(0.608)	(0.177)	(0.475)	(0.621)	(0.550)	(0.261)	(0.265)	(0.228)	(0.892)
Pos GoldMove		-0.002	0.005	-0.005	-0.001	0.003	0.003	0.002	0.002	0.002	0.011
t-test		(0.566)	(0.242)	(0.125)	(0.792)	(0.342)	(0.301)	(0.592)	(0.666)	(0.588)	(0.236)
Neg GoldMove		0.000	-0.015	0.000	-0.006	-0.009	0.000	0.039	-0.038		
t-test		(0.978)	(0.086)	(0.954)	(0.633)	(0.522)	(0.997)	(0.414)	(0.750)		
Resv.	+	0.038	0.229	0.400	0.630	0.593	0.427	0.519	1.037	1.529	2.081
t-test		(0.463)	(0.042)	(0.009)	(0.003)	(0.011)	(0.031)	(0.024)	(0.003)	(0.003)	(0.007)
*Pos Gold*Rsv*	0	-0.341	-0.463	0.193	0.080	0.079	-0.094	-0.310	-0.389	-0.477	-0.276
t-test		(0.068)	(0.126)	(0.476)	(0.785)	(0.776)	(0.618)	(0.062)	(0.111)	(0.146)	(0.612)
*Neg Gold*Rsv*	+	0.590	1.100	0.819	1.703	1.231	-3.599	-9.077	48.937		
t-test		(0.190)	(0.293)	(0.372)	(0.126)	(0.377)	(<0.001)	(<0.001)	(0.151)		
Contingent	0	0.036	0.046	-0.239	-0.274	-0.117	0.147	-0.029	-0.424	-0.598	-0.753
t-test		(0.691)	(0.778)	(0.366)	(0.373)	(0.733)	(0.546)	(0.912)	(0.130)	(0.132)	(0.275)
*Pos Gold*Con*	+	0.971	0.660	0.704	0.517	0.438	0.491	0.905	1.127	1.096	0.597
t-test		(0.104)	(0.269)	(0.179)	(0.301)	(0.318)	(0.082)	(0.007)	(0.001)	(0.001)	(0.060)
*Neg Gold*Con*	0	-1.314	-0.957	-1.154	-0.985	-0.125	2.314	3.270	-0.764		
t-test		(0.023)	(0.372)	(0.329)	(0.476)	(0.930)	(0.014)	(0.193)	(0.859)		

Table 15C: Future Change in reserves (T years ahead) and decomposed current total resources: including interactions with future change in gold price - decomposed into positive and negative changes (cont.).

	Pred.	T=1	T=2	T=3	T=4	T=5	T=6	T=7	T=8	T=9	T=10
Inferred	+	0.013	0.025	-0.016	-0.001	0.101	0.332	0.527	0.658	0.629	1.073
t-test		(0.733)	(0.708)	(0.825)	(0.993)	(0.554)	(0.116)	(0.104)	(0.090)	(0.150)	(0.158)
*Pos Gold*Inf*	+	0.529	0.343	0.429	0.315	0.107	-0.116	-0.182	-0.226	-0.137	-0.348
t-test		(0.121)	(0.373)	(0.094)	(0.258)	(0.673)	(0.530)	(0.394)	(0.345)	(0.642)	(0.463)
*Neg Gold*Inf*	0	-0.119	-0.243	-0.877	-1.179	-1.062	-0.153	0.287	-59.518		
t-test		(0.708)	(0.629)	(0.076)	(0.115)	(0.239)	(0.872)	(0.935)	(0.193)		
Acq		-0.001	0.003	0.003	0.003	0.004	0.006	0.009	0.015	0.021	0.030
t-test		(0.502)	(0.501)	(0.211)	(0.328)	(0.111)	(0.032)	(0.010)	(0.025)	(0.034)	(0.016)
*Acq * Resv.*	+	0.118	0.223	0.056	0.082	0.315	0.944	1.227	1.085	1.032	0.481
t-test		(0.439)	(0.240)	(0.758)	(0.586)	(0.060)	(<0.001)	(<0.001)	(<0.001)	(0.007)	(0.536)
Adj. R^2		0.100	0.228	0.505	0.548	0.598	0.734	0.750	0.745	0.736	0.668
F-test		(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(0.000)
Obs.		493	410	344	282	226	182	144	117	93	70
*Pos = Neg Gold*Inf.*		(0.172)	(0.309)	(0.044)	(0.056)	(0.181)	(0.971)	(0.866)	(0.858)		

All Resources variables are ounces per share. Future Reserves (Resv.) include concurrent extraction (undeflated by recovery rates). Reserves represent the economically-viable portion of Resources. Contingent (Con.) represents the economically-unviable portion of Resources. Inferred (Inf.) represents the untestable portion of Resources. Mineralised Material is Contingent plus Inferred. Developed Resources are Reserves plus Contingent. Acq is the percentage future change in the number of projects disclosing resources. GoldMove is the percentage future change in the spot price of gold (USD). Pos (Neg) Gold is the piece-wise positive (negative) decomposition of GoldMove. t-tests utilise White's diagonal corrected errors. p-values are two-tailed.

$$
\begin{aligned}
Resv_{i,t+T} - Resv_{i,t} &= \beta_0 + \beta_1 PosGold_{i,t+T} + \beta_2 NegGold_{i,t+T} + \beta_3 Resv_{i,t} + \beta_4 PosGold_{i,t+T} * Resv_{i,t} + \beta_5 NegGold_{i,t+T} * Resv_{i,t} \\
&+ \beta_6 Con_{i,t} + \beta_7 PosGold_{i,t+T} * Con_{i,t} + \beta_8 NegGold_{i,t+T} * Con_{i,t} + \beta_9 Inf_{i,t} + \beta_{10} PosGold_{i,t+T} * Inf_{i,t} \\
&+ \beta_{11} NegGold_{i,t+T} * Inf_{i,t} + \beta_{12} Acq_{i,t+T} + \beta_{13} Acq_{i,t+T} * Resv_{i,t} + \varepsilon_{i,t+T}
\end{aligned}
$$

Table 15D: Future change in reserves (T years ahead) and decomposed current total resources: including interactions with lagged change in gold price - decomposed into positive and negative changes.

	Pred.	T=1	T=2	T=3	T=4	T=5	T=6	T=7	T=8	T=9	T=10
Intercept		0.001	0.003	0.003	0.005	0.004	0.005	0.002	0.014	0.015	0.004
t-test		(0.353)	(0.047)	(0.063)	(0.011)	(0.090)	(0.073)	(0.705)	(0.132)	(0.229)	(0.516)
Pos GoldMove		0.000	-0.004	-0.006	-0.009	0.003	-0.008	-0.006			
t-test		(0.969)	(0.207)	(0.061)	(0.214)	(0.736)	(0.688)	(0.989)			
Neg GoldMove		0.001	0.007	0.006	0.019	0.010	0.009	-0.018	0.036	0.016	-0.040
t-test		(0.860)	(0.384)	(0.566)	(0.079)	(0.447)	(0.576)	(0.470)	(0.368)	(0.736)	(0.196)
Resv.	+	-0.039	-0.025	0.251	0.168	0.273	0.381	0.690	1.153	3.086	2.117
t-test		(0.624)	(0.873)	(0.097)	(0.484)	(0.321)	(0.115)	(0.035)	(0.011)	(<0.001)	(0.002)
*Pos Gold*Rsv*	0	0.050	0.239	0.610	1.127	0.088	11.816	42.717			
t-test		(0.905)	(0.664)	(0.093)	(0.057)	(0.907)	(0.001)	(0.005)			
*Neg Gold*Rsv*	+	-0.754	-0.561	-0.584	-1.761	-0.835	-0.121	2.061	2.277	9.682	3.085
t-test		(0.386)	(0.541)	(0.481)	(0.100)	(0.376)	(0.906)	(0.174)	(0.298)	(0.016)	(0.098)
Contingent	0	0.177	0.289	0.086	0.065	-0.055	-0.082	-0.338	-1.125	-2.148	-0.408
t-test		(0.132)	(0.053)	(0.521)	(0.791)	(0.840)	(0.751)	(0.393)	(0.020)	(0.012)	(0.428)
*Pos Gold*Con*	+	0.411	0.392	0.546	0.275	4.920	-4.738	-9.440			
t-test		(0.582)	(0.608)	(0.388)	(0.800)	(0.018)	(0.169)	(0.572)			
*Neg Gold*Con*	0	0.606	1.497	0.930	0.599	-1.514	-3.098	-5.938	-9.222	-11.836	-2.748
t-test		(0.672)	(0.101)	(0.401)	(0.621)	(0.184)	(0.018)	(0.006)	(0.001)	(0.006)	(0.023)

Table 15D: Future change in reserves (T years ahead) and decomposed current total resources: including interactions with lagged change in gold price - decomposed into positive and negative changes (cont.).

	Pred.	T=1	T=2	T=3	T=4	T=5	T=6	T=7	T=8	T=9	T=10
Inferred	+	0.088	0.124	0.294	0.454	0.460	0.539	0.726	0.521	-0.176	0.817
t-test		(0.272)	(0.142)	(0.005)	(0.013)	(0.008)	(0.104)	(0.190)	(0.380)	(0.888)	(0.098)
*Pos Gold*Inf*	+	-0.340	-0.077	-0.384	-0.517	-3.519	-2.568	-11.497			
t-test		(0.357)	(0.846)	(0.369)	(0.602)	(0.005)	(0.580)	(0.648)			
*Neg Gold*Inf*	0	0.632	0.380	0.998	1.382	1.015	1.136	1.845	0.453	-3.090	0.819
t-test		(0.438)	(0.474)	(0.025)	(0.058)	(0.159)	(0.362)	(0.429)	(0.863)	(0.613)	(0.659)
Acq		0.000	0.002	0.003	0.002	0.002	0.006	0.010	0.015	0.020	0.028
t-test		(0.674)	(0.557)	(0.268)	(0.649)	(0.528)	(0.032)	(0.023)	(0.028)	(0.041)	(0.014)
*Acq * Resv.*	+	0.127	0.258	0.097	0.144	0.602	0.875	1.162	0.940	0.929	0.737
t-test		(0.397)	(0.212)	(0.590)	(0.257)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(0.001)	(0.346)
Adj. R^2		0.078	0.228	0.495	0.528	0.591	0.727	0.747	0.725	0.717	0.671
F-test		(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Obs.		493	410	344	282	226	182	144	117	93	70

All Resources variables are ounces per share. Future Reserves (Resv.) include concurrent extraction (undeflated by recovery rates). Reserves represent the economically-viable portion of Resources. Contingent (Con.) represents the economically-unviable portion of Resources. Inferred (Inf.) represents the untestable portion of Resources. Mineralised Material is Contingent plus Inferred. Developed Resources are Reserves plus Contingent. Acq is the percentage future change in the number of projects disclosing resources. GoldMove is the percentage lagged change in the spot price of gold (USD). Pos (Neg) Gold is the piece-wise positive (negative) decomposition of GoldMove. t-tests utilise White's diagonal corrected errors. p-values are two-tailed.

$$Resv_{i,t+T} - Resv_{i,t} = \beta_0 + \beta_1 PosGold_{i,t-T} + \beta_2 NegGold_{i,t-T} + \beta_3 Resv_{i,t} + \beta_4 PosGold_{i,t-T} * Resv_{i,t} + \beta_5 NegGold_{i,t-T} * Resv_{i,t} + \beta_6 Con_{i,t} + \beta_7 PosGold_{i,t-T} * Con_{i,t} + \beta_8 NegGold_{i,t-T} * Con_{i,t} + \beta_9 Inf_{i,t} + \beta_{10} PosGold_{i,t-T} * Inf_{i,t} + \beta_{11} NegGold_{i,t-T} * Inf_{i,t} + \beta_{12} Acq_{i,t+T} + \beta_{13} Acq_{i,t+T} * Resv_{i,t} + \varepsilon_{i,t+T}$$

Table 16A: Market value and current total resources decomposed into reserves and contingent resources: including interactions with lagged change in gold price.

	Pred.	T=1	T=2	T=3	T=4	T=5	T=6	T=7	T=8	T=9	T=10
Intercept		-0.244	-0.179	-0.216	0.837	0.863	0.826	0.381	0.553	0.751	0.078
t-test		(0.498)	(0.682)	(0.554)	(0.039)	(0.025)	(0.049)	(0.322)	(0.200)	(0.059)	(0.855)
GoldMove		-0.387	1.343	0.721	0.523	0.613	0.594	0.720	0.601	0.612	0.678
t-test		(0.737)	(0.118)	(0.165)	(0.222)	(0.065)	(0.046)	(0.005)	(0.025)	(0.019)	(0.016)
SResv.	+	0.164	0.112	0.011	-0.071	-0.084	0.001	0.047	0.121	0.099	0.214
t-test		(<0.001)	(0.014)	(0.746)	(0.095)	(0.035)	(0.973)	(0.196)	(0.002)	(0.004)	(<0.001)
*GoldMove*SResv.*	+	0.463	0.317	0.325	0.322	0.259	0.185	0.136	0.114	0.124	0.069
t-test		(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
SCon.	0	-0.042	-0.025	0.026	0.018	0.055	0.079	0.087	0.084	0.083	0.080
t-test		(0.212)	(0.686)	(0.526)	(0.701)	(0.184)	(0.070)	(0.035)	(0.056)	(0.043)	(0.072)
*GoldMove*SCon.*	+	-0.284	-0.310	-0.347	-0.301	-0.262	-0.226	-0.205	-0.192	-0.201	-0.173
t-test		(0.100)	(0.072)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
SBypr.	+	-0.114	-0.113	-0.116	-0.110	-0.119	-0.121	-0.105	-0.099	-0.102	-0.088
t-test		(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)

Table 16A: Market value and current total resources decomposed into reserves and contingent resources: including interactions with lagged change in gold price (cont.).

	Pred.	T=1	T=2	T=3	T=4	T=5	T=6	T=7	T=8	T=9	T=10
BVEa	+	1.682	1.970	1.451	1.636	1.780	1.761	1.891	1.883	1.906	1.900
t-test		(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Sunk	+	1.707	1.626	1.638	1.270	1.380	1.188	1.181	0.895	0.888	1.017
t-test		(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
CapEx.	+	1.788	2.481	3.014	3.065	3.011	2.423	2.751	2.196	2.335	1.632
t-test		(0.006)	(0.001)	(<0.001)	(<0.001)	(<0.001)	(0.001)	(<0.001)	(0.003)	(0.001)	(0.032)
Adj. R^2		0.927	0.907	0.933	0.931	0.935	0.925	0.927	0.918	0.925	0.912
F-test		(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Obs.		321	321	321	321	321	321	321	321	321	321

All variables are in USD per share. All Resources variables are multiplied by the USD spot price. Market value of equity (MVE) is the stock price six months after the financial year end. Reserves (Resv.) represent the economically-viable portion of Resources. Contingent (Con.) represents the economically-unviable portion of Resources. Inferred represents the untestable portion of Resources. Mineralised Material is Contingent plus Inferred. Developed Resources are Reserves plus Contingent. Bypr is commodities other than gold (total resources). BVEa is the book value of ordinary equity minus Sunk and CapEx. Sunk is the book value of property, plant and equipment, and intangible assets. CapEx is the expected future expenditure on Sunk (from the feasibility report). GoldMove is the percentage lagged change in the spot price of gold (USD). Pos (Neg) Gold is the piece-wise positive (negative) decomposition of GoldMove. Regressions include adjustments for cross-sectional fixed effects. t-tests utilise White's diagonal corrected errors. p-values are two-tailed.

$$MVE_{i,t} = \beta_0 + \beta_1 GoldMove_{i,t-T} + \beta_2 SResv_{i,t} + \beta_3 GoldMove_{i,t-T} * SResv_{i,t} + \beta_4 SCon_{i,t} + \beta_5 GoldMove_{i,t-T} * SCon_{i,t} + \beta_6 SBypr_{i,t} + \beta_7 BVEa_{i,t} + \beta_8 Sunk_{i,t} + \beta_9 CapEx_{i,t} + \varepsilon_{i,t}$$

Table 16B: Market value and current total resources decomposed into reserves and contingent resources: including interactions with lagged change in gold price - decomposed into positive and negative changes.

	Pred.	T=1	T=2	T=3	T=4	T=5	T=6	T=7	T=8	T=9	T=10
Intercept		-0.165	-0.446	-0.201	1.158	1.078	1.018	0.653	0.577	0.870	0.074
t-test		(0.678)	(0.384)	(0.645)	(0.019)	(0.018)	(0.044)	(0.159)	(0.481)	(0.236)	(0.926)
PosGold		-0.499	2.371	0.777	0.277	0.398	0.457	0.556	0.618	0.622	0.651
t-test		(0.739)	(0.047)	(0.280)	(0.635)	(0.341)	(0.213)	(0.066)	(0.108)	(0.091)	(0.060)
NegGold		0.246	-1.677	-0.310	1.661	1.260	0.979	0.785	-0.390	-0.010	-0.404
t-test		(0.943)	(0.568)	(0.882)	(0.379)	(0.446)	(0.620)	(0.695)	(0.773)	(0.995)	(0.678)
SResv.	+	0.156	0.084	-0.024	-0.127	-0.104	-0.015	0.034	0.099	0.065	0.198
t-test		(<0.001)	(0.077)	(0.503)	(0.005)	(0.012)	(0.738)	(0.371)	(0.146)	(0.292)	(0.004)
*PosGold*SResv.*	0	0.497	0.380	0.370	0.385	0.275	0.194	0.138	0.124	0.139	0.070
t-test		(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(0.003)	(0.004)	(0.033)
*NegGold*SResv.*	+	0.230	0.052	0.189	-0.077	0.204	0.213	0.435	0.074	0.079	0.263
t-test		(0.472)	(0.823)	(0.257)	(0.627)	(0.131)	(0.173)	(0.007)	(0.793)	(0.811)	(0.333)
SCon.	0	-0.022	0.075	0.110	0.153	0.115	0.133	0.105	0.188	0.207	0.117
t-test		(0.572)	(0.338)	(0.050)	(0.020)	(0.045)	(0.041)	(0.130)	(0.072)	(0.120)	(0.223)
*PosGold*SCon.*	+	-0.364	-0.553	-0.479	-0.433	-0.310	-0.263	-0.219	-0.237	-0.257	-0.188
t-test		(0.063)	(0.008)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(0.002)	(0.003)	(0.003)
*NegGold*SCon.*	0	0.942	1.321	1.400	0.750	0.340	0.308	0.072	0.693	0.944	0.499
t-test		(0.488)	(0.358)	(0.055)	(0.086)	(0.318)	(0.412)	(0.860)	(0.199)	(0.175)	(0.252)
SBypr.	+	-0.113	-0.110	-0.116	-0.112	-0.119	-0.120	-0.104	-0.100	-0.102	-0.089
t-test		(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(0.005)	(0.001)	(0.012)

Table 16B: Market value and current total resources decomposed into reserves and contingent resources: including interactions with lagged change in gold price - decomposed into positive and negative changes (cont.).

	Pred.	T=1	T=2	T=3	T=4	T=5	T=6	T=7	T=8	T=9	T=10
BVE	+	1.678	1.932	1.426	1.575	1.683	1.622	1.636	1.753	1.742	1.698
t-test		(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(0.002)	(0.002)	(0.004)
Sunk	+	1.702	1.610	1.640	1.156	1.372	1.191	1.212	0.845	0.829	1.077
t-test		(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(0.007)	(0.013)	(0.003)
CapEx.	+	1.718	2.331	3.090	2.919	2.915	2.296	2.630	2.036	2.181	1.638
t-test		(0.008)	(0.003)	(<0.001)	(<0.001)	(<0.001)	(0.001)	(<0.001)	(0.085)	(0.101)	(0.166)
Adj. R^2		0.927	0.908	0.934	0.933	0.936	0.925	0.928	0.918	0.926	0.913
F-test		(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Obs.		321	321	321	321	321	321	321	321	321	321
Pos = Neg Gold		(0.836)	(0.198)	(0.620)	(0.481)	(0.599)	(0.783)	(0.903)	(0.632)	(0.753)	(0.497)
*Pos = Neg Gold*SResv.*		(0.367)	(0.148)	(0.249)	(0.003)	(0.571)	(0.892)	(0.042)	(0.791)	(0.746)	(0.175)
*Pos = Neg Gold*SCon.*		(0.295)	(0.160)	(0.006)	(0.005)	(0.046)	(0.109)	(0.449)	(0.050)	(0.014)	(0.082)

All variables are in USD per share. All Resources variables are multiplied by the USD spot price. Market value of equity (MVE) is the stock price six months after the financial year end. Reserves (Resv.) represent the economically-viable portion of Resources. Contingent (Con.) represents the economically-unviable portion of Resources. Inferred represents the untestable portion of Resources. Mineralised Material is Contingent plus Inferred. Developed Resources are Reserves plus Contingent. Bypr is commodities other than gold (total resources). BVE is the book value of ordinary equity minus Sunk and CapEx. Sunk is the book value of property, plant and equipment, and intangible assets. CapEx is the expected future expenditure on Sunk (from the feasibility report). GoldMove is the percentage lagged change in the spot price of gold (USD). Pos (Neg) Gold is the piece-wise positive (negative) decomposition of GoldMove. Regressions include adjustments for cross-sectional fixed effects. t-tests utilise White's diagonal corrected errors. p-values are two-tailed.

$$MVE_{i,t} = \beta_0 + \beta_1 PosGold_{i,t-T} + \beta_2 NegGold_{i,t-T} + \beta_3 SResv_{i,t} + \beta_4 PosGold_{i,t-T} * SResv_{i,t} + \beta_5 NegGold_{i,t-T} * SResv_{i,t} + \beta_6 SCon_{i,t} + \beta_7 PosGold_{i,t-T} * SCon_{i,t} + \beta_8 NegGold_{i,t-T} * SCon_{i,t} + \beta_9 SBypr_{i,t} + \beta_{10} BVEa_{i,t} + \beta_{11} Sunk_{i,t} + \beta_{12} CapEx_{i,t} + \varepsilon_{i,t}$$

Table 16C: Market value and current total resources decomposed into reserves, contingent and inferred resources: including interactions with lagged change in gold price - decomposed into positive and negative changes.

	Pred.	T=1	T=2	T=3	T=4	T=5	T=6	T=7	T=8	T=9	T=10
Intercept		0.040	-0.004	0.148	1.279	1.394	1.371	1.075	0.876	1.225	0.284
t-test		(0.923)	(0.995)	(0.755)	(0.017)	(0.005)	(0.012)	(0.031)	(0.276)	(0.102)	(0.715)
PosGold		-1.091	1.360	0.214	0.165	0.158	0.213	0.291	0.460	0.427	0.543
t-test		(0.507)	(0.295)	(0.785)	(0.793)	(0.730)	(0.592)	(0.373)	(0.209)	(0.226)	(0.106)
NegGold		1.093	-0.382	0.178	1.738	1.273	1.895	1.568	0.622	0.731	0.061
t-test		(0.756)	(0.900)	(0.936)	(0.392)	(0.482)	(0.377)	(0.467)	(0.675)	(0.603)	(0.948)
SResv.	+	0.158	0.081	-0.024	-0.127	-0.109	-0.022	0.027	0.104	0.070	0.195
t-test		(<0.001)	(0.088)	(0.509)	(0.006)	(0.009)	(0.620)	(0.491)	(0.107)	(0.225)	(0.004)
*PosGold*SResv.*	0	0.483	0.345	0.355	0.380	0.268	0.191	0.132	0.118	0.134	0.069
t-test		(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(0.003)	(0.002)	(0.032)
*NegGold*SResv.*	+	0.227	0.070	0.146	-0.090	0.172	0.222	0.443	0.120	0.073	0.279
t-test		(0.556)	(0.797)	(0.441)	(0.609)	(0.251)	(0.192)	(0.013)	(0.649)	(0.833)	(0.318)
SCon.	0	0.009	0.083	0.136	0.160	0.132	0.184	0.139	0.222	0.278	0.153
t-test		(0.827)	(0.301)	(0.023)	(0.021)	(0.026)	(0.008)	(0.049)	(0.045)	(0.067)	(0.125)
*PosGold*SCon.*	+	-0.409	-0.568	-0.513	-0.437	-0.322	-0.290	-0.237	-0.248	-0.282	-0.201
t-test		(0.042)	(0.008)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(0.003)	(0.003)	(0.005)
*NegGold*SCon.*	0	1.356	1.311	1.622	0.788	0.432	0.519	0.188	0.805	1.178	0.605
t-test		(0.326)	(0.362)	(0.029)	(0.078)	(0.211)	(0.181)	(0.646)	(0.144)	(0.112)	(0.156)
SInf.	+	-0.072	-0.108	-0.070	-0.027	-0.062	-0.095	-0.096	-0.113	-0.151	-0.071
t-test		(0.064)	(0.057)	(0.106)	(0.562)	(0.125)	(0.040)	(0.027)	(0.143)	(0.125)	(0.204)
*PosGold*SInf.*	+	0.133	0.292	0.121	0.027	0.054	0.061	0.062	0.049	0.063	0.030
t-test		(0.347)	(0.067)	(0.093)	(0.638)	(0.196)	(0.112)	(0.038)	(0.348)	(0.238)	(0.453)
*NegGold*SInf.*	0	-0.429	-0.406	-0.091	-0.009	0.036	-0.314	-0.221	-0.454	-0.540	-0.262
t-test		(0.460)	(0.439)	(0.802)	(0.978)	(0.891)	(0.306)	(0.460)	(0.444)	(0.342)	(0.402)

Table 16C: Market value and current total resources decomposed into reserves, contingent and inferred resources: including interactions with lagged change in gold price - decomposed into positive and negative changes.

	Pred.	T=1	T=2	T=3	T=4	T=5	T=6	T=7	T=8	T=9	T=10
SBypr.	+	-0.114	-0.105	-0.111	-0.110	-0.113	-0.118	-0.099	-0.098	-0.099	-0.089
t-test		(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(0.012)	(0.002)	(0.023)
BVE	+	1.648	1.807	1.353	1.558	1.616	1.658	1.651	1.884	1.822	1.750
t-test		(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(0.003)	(0.001)	(0.004)
Sunk	+	1.729	1.607	1.637	1.163	1.390	1.212	1.235	0.897	0.843	1.078
t-test		(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(0.008)	(0.013)	(0.004)
CapEx.	+	1.735	2.224	2.964	2.884	2.819	2.390	2.669	2.236	2.241	1.742
t-test		(0.008)	(0.004)	(<0.001)	(<0.001)	(<0.001)	(0.001)	(<0.001)	(0.090)	(0.093)	(0.166)
Adj. R^2		0.927	0.908	0.934	0.932	0.936	0.925	0.929	0.918	0.927	0.913
F-test		(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Obs.		321	321	321	321	321	321	321	321	321	321
*Pos = Neg Gold*SInf.*		(0.305)	(0.181)	(0.536)	(0.904)	(0.939)	(0.182)	(0.298)	(0.202)	(0.092)	(0.242)

All variables are in USD per share. All Resources variables are multiplied by the USD spot price. Market value of equity (MVE) is the stock price six months after the financial year end. Reserves (Resv.) represent the economically-viable portion of Resources. Contingent (Con.) represents the economically-unviable portion of Resources. Inferred (Inf.) represents the untestable portion of Resources. Mineralised Material is Contingent plus Inferred. Developed Resources are Reserves plus Contingent. Bypr is commodities other than gold (total resources). BVE is the book value of ordinary equity minus Sunk and CapEx. Sunk is the book value of property, plant and equipment, and intangible assets. CapEx is the expected future expenditure on Sunk (from the feasibility report). GoldMove is the percentage lagged change in the spot price of gold (USD). Pos (Neg) Gold is the piece-wise positive (negative) decomposition of GoldMove. Regressions include adjustments for cross-sectional fixed effects. t-tests utilise White's diagonal corrected errors. p-values are two-tailed.

$$MVE_{i,t} = \beta_0 + \beta_1 PosGold_{i,t-T} + \beta_2 NegGold_{i,t-T} + \beta_3 SResv_{i,t} + \beta_4 PosGold_{i,t-T} * SResv_{i,t} + \beta_5 NegGold_{i,t-T} * SResv_{i,t} + \beta_6 SCon_{i,t} + \beta_7 PosGold_{i,t-T} * SCon_{i,t} + \beta_8 NegGold_{i,t-T} * SCon_{i,t} + \beta_9 SInf_{i,t} + \beta_{10} PosGold_{i,t-T} * SInf_{i,t} + \beta_{11} NegGold_{i,t-T} * SInf_{i,t} + \beta_{12} SBypr_{i,t} + \beta_{13} BVEa_{i,t} + \beta_{14} Sunk_{i,t} + \beta_{15} CapEx_{i,t} + \varepsilon_{i,t}$$

Table 17A: Future change in developed resources (T years ahead) and current total resources – decomposed into developed and inferred resources.

	Pred.	T=1	T=2	T=3	T=4	T=5	T=6	T=7	T=8	T=9	T=10
Intercept		0.003	0.005	0.006	0.010	0.014	0.018	0.023	0.027	0.032	0.037
t-test		(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(0.001)
Dev.	+	0.022	0.061	0.168	0.218	0.250	0.359	0.430	0.502	0.612	0.689
t-test		(0.304)	(0.217)	(0.090)	(0.083)	(0.074)	(0.008)	(0.003)	(0.013)	(0.013)	(0.007)
Inf.	+	0.019	0.056	0.123	0.158	0.131	0.072	0.115	0.185	0.164	0.292
t-test		(0.639)	(0.401)	(0.185)	(0.168)	(0.308)	(0.605)	(0.553)	(0.533)	(0.621)	(0.564)
Acq		0.003	0.004	0.002	0.000	0.003	0.005	0.009	0.013	0.022	0.030
t-test		(0.396)	(0.306)	(0.610)	(0.980)	(0.563)	(0.294)	(0.155)	(0.142)	(0.032)	(0.015)
*Acq * Dev.*	+	0.264	0.430	0.559	0.648	0.780	1.211	1.340	1.381	1.550	1.677
t-test		(0.207)	(0.008)	(0.002)	(0.002)	(0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Adj. R^2		0.097	0.234	0.324	0.408	0.488	0.669	0.717	0.710	0.705	0.670
F-test		(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Obs.		493	410	344	282	226	182	144	117	93	70

All Resources variables are ounces per share. Future Reserves include concurrent extraction (undeflated by recovery rates). Reserves represent the economically-viable portion of Resources. Contingent represents the economically-unviable portion of Resources. Inferred (Inf.) represents the untestable portion of Resources. Mineralised Material is Contingent plus Inferred. Developed Resources (Dev.) are Reserves plus Contingent. Acq is the percentage future change in the number of projects disclosing resources. Exploration is the sum of future expenditure on exploration (USD, deflated by Current Reserves). Regressions include adjustments for period fixed effects. t-tests utilise White's diagonal corrected errors. p-values are two-tailed.

$$Dev_{i,t+T} - Dev_{i,t} = \beta_0 + \beta_1 Dev_{i,t} + \beta_2 Inf_{i,t} + \beta_3 Acq_{i,t+T} + \beta_4 Acq_{i,t+T} * Dev_{i,t} + \varepsilon_{i,t+T}$$

Table 17B: Future change in developed resources (T years ahead) and current total resources – decomposed into developed and inferred resources: including interactions with future exploration expenditure.

	Pred.	T=1	T=2	T=3	T=4	T=5	T=6	T=7	T=8	T=9	T=10
Intercept		0.001	0.003	0.004	0.006	0.010	0.014	0.021	0.026	0.031	0.038
t-test		(0.028)	(0.023)	(0.024)	(0.007)	(0.001)	(<0.001)	(0.001)	(0.001)	(0.002)	(0.004)
Expl.		-0.001	-0.001	-0.001	0.000	-0.001	-0.005	-0.012	-0.015	-0.016	-0.017
t-test		(0.055)	(0.040)	(0.415)	(0.668)	(0.309)	(0.121)	(0.072)	(0.060)	(0.060)	(0.081)
Dev.	+	0.017	0.034	0.116	0.153	0.175	0.257	0.313	0.394	0.510	0.571
t-test		(0.413)	(0.450)	(0.262)	(0.242)	(0.223)	(0.044)	(0.020)	(0.060)	(0.060)	(0.023)
*Expl.*Dev.*	+	6.630	7.548	5.215	4.239	3.440	3.206	2.387	1.629	1.467	1.131
t-test		(0.013)	(0.001)	(0.008)	(0.014)	(0.013)	(<0.001)	(0.003)	(0.017)	(0.052)	(0.174)
Inf.	0	0.012	0.076	0.151	0.210	0.196	0.160	0.162	0.198	0.161	0.231
t-test		(0.764)	(0.240)	(0.096)	(0.068)	(0.133)	(0.264)	(0.412)	(0.506)	(0.619)	(0.645)
*Expl.*Inf.*	+	0.665	0.041	0.080	-0.016	-0.016	0.168	0.409	0.776	0.897	1.010
t-test		(0.287)	(0.826)	(0.616)	(0.932)	(0.938)	(0.385)	(0.114)	(0.015)	(0.007)	(0.007)
Acq		0.002	0.002	0.000	-0.002	0.000	0.002	0.009	0.015	0.025	0.035
t-test		(0.568)	(0.506)	(0.984)	(0.620)	(0.968)	(0.641)	(0.133)	(0.076)	(0.010)	(0.002)
*Acq * Dev.*	+	0.290	0.470	0.608	0.704	0.843	1.296	1.408	1.414	1.558	1.688
t-test		(0.176)	(0.005)	(0.001)	(0.002)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Adj. R^2		0.130	0.282	0.352	0.432	0.509	0.694	0.736	0.726	0.720	0.685
F-test		(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Obs.		493	410	344	282	226	182	144	117	93	70

All Resources variables are ounces per share. Future Reserves include concurrent extraction (undeflated by recovery rates). Reserves represent the economically-viable portion of Resources. Contingent represents the economically-unviable portion of Resources. Inferred represents the untestable portion of Resources. Mineralised Material is Contingent plus Inferred. Developed Resources (Dev.) are Reserves plus Contingent. Acq is the percentage future change in the number of projects disclosing resources. Expl is the sum of future expenditure on exploration (USD, deflated by Current Reserves). Regressions include adjustments for period fixed effects. t-tests utilise White's diagonal corrected errors. p-values are two-tailed.

$$Dev_{i,t+T} - Dev_{i,t} = \beta_0 + \beta_1 Expl_{i,t+T} + \beta_2 Dev_{i,t} + \beta_3 Expl_{i,t+T} * Dev_{i,t} + \beta_4 Inf_{i,t} + \beta_5 Expl_{i,t+T} * Inf_{i,t} + \beta_6 Acq_{i,t+T} + \beta_7 Acq_{i,t+T} * Dev_{i,t} + \varepsilon_{i,t+T}$$

Table 17C: Future change in reserves (T years ahead) and current total resources – decomposed into reserves, contingent and inferred resources: including interactions with future exploration expenditure.

	Pred.	T=1	T=2	T=3	T=4	T=5	T=6	T=7	T=8	T=9	T=10
Intercept		0.000	0.001	0.000	0.000	0.002	0.004	0.009	0.011	0.016	0.017
t-test		(0.679)	(0.432)	(0.656)	(0.964)	(0.385)	(0.178)	(0.071)	(0.086)	(0.033)	(0.129)
Expl.		0.000	0.000	0.000	0.000	0.000	-0.001	-0.003	-0.005	-0.006	-0.005
t-test		(0.215)	(0.385)	(0.285)	(0.647)	(0.928)	(0.320)	(0.115)	(0.063)	(0.043)	(0.126)
Resv.	+	-0.003	0.065	0.379	0.473	0.475	0.515	0.553	0.835	1.188	1.965
t-test		(0.935)	(0.341)	(<0.001)	(0.001)	(0.020)	(<0.001)	(0.005)	(0.001)	(0.008)	(0.027)
*Expl.*Resv.*	+	4.541	5.024	3.696	3.359	2.738	1.930	1.345	0.694	0.073	-0.693
t-test		(0.029)	(0.003)	(0.001)	(0.002)	(0.002)	(0.001)	(0.056)	(0.307)	(0.925)	(0.486)
Con.	?	0.141	0.102	-0.063	-0.114	-0.045	0.076	0.110	-0.035	-0.166	-0.672
t-test		(0.051)	(0.308)	(0.531)	(0.409)	(0.819)	(0.625)	(0.627)	(0.906)	(0.694)	(0.326)
*Expl.*Con.*	+	-0.499	-0.151	0.014	-0.062	-0.099	0.001	0.108	0.276	0.470	0.701
t-test		(0.110)	(0.180)	(0.905)	(0.614)	(0.479)	(0.994)	(0.567)	(0.162)	(0.068)	(0.034)

Table 17C: Future change in reserves (T years ahead) and current total resources – decomposed into reserves, contingent and inferred resources: including interactions with future exploration expenditure (cont.).

	Pred.	T=1	T=2	T=3	T=4	T=5	T=6	T=7	T=8	T=9	T=10
Inf.	0	0.009	0.065	0.151	0.227	0.246	0.235	0.238	0.305	0.270	0.426
t-test		(0.795)	(0.218)	(0.006)	(0.003)	(0.009)	(0.022)	(0.120)	(0.213)	(0.329)	(0.319)
*Expl.*Inf.*	+	0.673	0.052	0.107	0.114	0.126	0.200	0.230	0.422	0.518	0.597
t-test		(0.219)	(0.741)	(0.360)	(0.390)	(0.346)	(0.052)	(0.075)	(0.005)	(0.004)	(0.007)
Acq		-0.001	0.001	0.001	-0.001	0.001	0.003	0.008	0.013	0.023	0.032
t-test		(0.587)	(0.774)	(0.766)	(0.718)	(0.708)	(0.396)	(0.136)	(0.117)	(0.036)	(0.019)
*Acq * Resv.*	+	0.121	0.251	0.183	0.251	0.430	0.855	0.933	0.819	0.700	0.266
t-test		(0.426)	(0.181)	(0.270)	(0.091)	(0.037)	(<0.001)	(<0.001)	(<0.001)	(0.050)	(0.684)
Adj. R^2		0.097	0.241	0.475	0.516	0.578	0.712	0.706	0.702	0.703	0.652
F-test		(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Obs.		493	410	344	282	226	182	144	117	93	70

All Resources variables are ounces per share. Future Reserves (Resv.) include concurrent extraction (undeflated by recovery rates). Reserves represent the economically-viable portion of Resources. Contingent (Con.) represents the economically-unviable portion of Resources. Inferred (Inf.) represents the untestable portion of Resources. Mineralised Material is Contingent plus Inferred. Developed Resources are Reserves plus Contingent. Acq is the percentage future change in the number of projects disclosing resources. Expl is the sum of future expenditure on exploration (USD, deflated by Current Reserves). Regressions include adjustments for period fixed effects. t-tests utilise White's diagonal corrected errors. p-values are two-tailed.

$$Resv_{i,t+T} - Resv_{i,t} = \beta_0 + \beta_1 Expl_{i,t+T} + \beta_2 Resv_{i,t} + \beta_3 Expl_{i,t+T} * Resv_{i,t} + \beta_4 Con_{i,t} + \beta_5 Expl_{i,t+T} * Con_{i,t} + \beta_6 Inf_{i,t} + \beta_7 Expl_{i,t+T} * Inf_{i,t} + \beta_8 Acq_{i,t+T} + \beta_9 Acq_{i,t+T} * Resv_{i,t} + \varepsilon_{i,t+T}$$

Table 17D: Future change in reserves (T years ahead) and current total resources – decomposed into reserves, contingent and inferred resources: including interactions with current exploration expenditure.

	Pred.	T=1	T=2	T=3	T=4	T=5	T=6	T=7	T=8	T=9	T=10
Intercept		0.001	0.001	0.001	0.002	0.004	0.007	0.012	0.017	0.027	0.035
t-test		(0.144)	(0.200)	(0.458)	(0.309)	(0.080)	(0.036)	(0.018)	(0.023)	(0.002)	(0.015)
Expl.		0.000	0.000	0.000	0.000	0.001	0.005	-0.018	-0.038	-0.080	-0.144
t-test		(0.934)	(0.976)	(0.879)	(0.931)	(0.799)	(0.789)	(0.565)	(0.398)	(0.212)	(0.338)
Resv.	+	-0.003	0.062	0.379	0.458	0.444	0.473	0.488	0.785	1.297	2.342
t-test		(0.935)	(0.364)	(0.000)	(0.002)	(0.033)	(0.002)	(0.025)	(0.004)	(0.007)	(0.007)
*Expl.*Resv.*	+	0.449	9.601	5.457	11.374	12.217	6.597	4.050	-6.744	-35.271	-65.071
t-test		(0.770)	(0.014)	(0.232)	(0.089)	(0.157)	(0.488)	(0.745)	(0.645)	(0.032)	(0.006)
Con.	?	0.156	0.135	-0.002	-0.038	0.045	0.205	0.271	0.173	0.050	-0.430
t-test		(0.029)	(0.166)	(0.987)	(0.786)	(0.818)	(0.188)	(0.227)	(0.557)	(0.902)	(0.434)
*Expl.*Con.*	+	-0.312	-0.341	0.638	0.611	0.488	0.342	1.396	2.236	3.419	6.681
t-test		(0.173)	(0.306)	(0.020)	(0.107)	(0.371)	(0.696)	(0.331)	(0.262)	(0.199)	(0.227)

Table 17D: Future change in reserves (T years ahead) and current total resources – decomposed into reserves, contingent and inferred resources: including interactions with current exploration expenditure (cont.).

	Pred.	T=1	T=2	T=3	T=4	T=5	T=6	T=7	T=8	T=9	T=10
Inf.	0	0.008	0.053	0.130	0.191	0.202	0.184	0.181	0.217	0.116	0.157
t-test		(0.843)	(0.322)	(0.023)	(0.014)	(0.035)	(0.078)	(0.257)	(0.400)	(0.686)	(0.735)
*Expl.*Inf.*	+	0.489	-0.211	0.095	-0.174	-0.460	-0.290	-0.034	1.870	5.211	9.224
t-test		(0.429)	(0.615)	(0.846)	(0.810)	(0.681)	(0.836)	(0.987)	(0.443)	(0.087)	(0.089)
Acq		0.000	0.001	0.002	0.000	0.002	0.004	0.008	0.014	0.027	0.040
t-test		(0.825)	(0.745)	(0.592)	(0.907)	(0.523)	(0.275)	(0.129)	(0.117)	(0.024)	(0.008)
*Acq * Resv.*	+	0.114	0.249	0.188	0.263	0.447	0.887	0.978	0.844	0.638	0.022
t-test		(0.461)	(0.184)	(0.260)	(0.080)	(0.032)	(<0.001)	(<0.001)	(<0.001)	(0.099)	(0.972)
Adj. R^2		0.069	0.219	0.445	0.491	0.555	0.692	0.689	0.683	0.696	0.664
F-test		(0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Obs.		493	410	344	282	226	182	144	117	93	70

All Resources variables are ounces per share. Future Reserves (Resv.) include concurrent extraction (undeflated by recovery rates). Reserves represent the economically-viable portion of Resources. Contingent (Con.) represents the economically-unviable portion of Resources. Inferred (Inf.) represents the untestable portion of Resources. Mineralised Material is Contingent plus Inferred. Developed Resources are Reserves plus Contingent. Acq is the percentage future change in the number of projects disclosing resources. Expl is current expenditure on exploration (USD, deflated by Current Reserves). Regressions include adjustments for period fixed effects. t-tests utilise White's diagonal corrected errors. p-values are two-tailed.

$$Resv_{i,t+T} - Resv_{i,t} = \beta_0 + \beta_1 Expl_{i,t} + \beta_2 Resv_{i,t} + \beta_3 Expl_{i,t} * Resv_{i,t} + \beta_4 Con_{i,t} + \beta_5 Expl_{i,t} * Con_{i,t} + \beta_6 Inf_{i,t} + \beta_7 Expl_{i,t} * Inf_{i,t} + \beta_8 Acq_{i,t+T} + \beta_9 Acq_{i,t+T} * Resv_{i,t} + \varepsilon_{i,t+T}$$

Table 18A: Future change in reserves (T years ahead) and current total resources – decomposed into reserves, contingent and inferred resources: including interactions with future exploration expenditure and the proportion of developed resources that are reserves.

	Pred.	T=1	T=2	T=3	T=4	T=5	T=6	T=7	T=8	T=9	T=10
Intercept		0.000	0.001	0.003	0.004	0.007	0.010	0.022	0.033	0.031	0.029
t-test		(0.857)	(0.779)	(0.175)	(0.154)	(0.129)	(0.079)	(0.031)	(0.021)	(0.058)	(0.202)
Expl.		0.000	0.000	0.000	0.000	0.000	-0.001	-0.006	-0.009	-0.008	-0.007
t-test		(0.169)	(0.545)	(0.291)	(0.660)	(0.821)	(0.520)	(0.104)	(0.055)	(0.092)	(0.214)
Resv./Dev.		0.001	0.001	-0.005	-0.006	-0.007	-0.009	-0.019	-0.030	-0.019	-0.014
t-test		(0.542)	(0.779)	(0.111)	(0.170)	(0.269)	(0.193)	(0.106)	(0.088)	(0.387)	(0.712)
Resv.	+	-0.001	0.061	0.389	0.477	0.475	0.508	0.572	0.817	1.076	1.663
t-test		(0.985)	(0.404)	(<0.001)	(0.002)	(0.030)	(0.001)	(0.005)	(0.001)	(0.022)	(0.064)
*Expl.*Resv.*	+	4.347	4.921	3.610	3.185	2.630	1.934	1.660	1.385	0.382	-0.506
t-test		(0.048)	(0.004)	(0.001)	(0.003)	(0.004)	(0.004)	(0.030)	(0.055)	(0.639)	(0.650)
Con.	?	0.126	0.113	-0.085	-0.103	-0.022	0.112	0.102	-0.034	-0.061	-0.287
t-test		(0.136)	(0.349)	(0.471)	(0.542)	(0.927)	(0.509)	(0.668)	(0.916)	(0.898)	(0.689)
*Expl.*Con.*	+	0.002	-0.043	0.104	-0.026	-0.108	-0.065	-0.049	0.005	0.311	0.516
t-test		(0.996)	(0.780)	(0.537)	(0.898)	(0.653)	(0.713)	(0.827)	(0.983)	(0.212)	(0.110)
Inf.	0	0.086	0.044	0.076	0.007	-0.018	-0.118	-0.489	-0.778	-0.853	-1.264
t-test		(0.348)	(0.704)	(0.506)	(0.960)	(0.910)	(0.519)	(0.086)	(0.027)	(0.037)	(0.015)
*Expl.*Inf.*	0	-1.711	-0.526	-0.425	-0.163	0.046	0.281	1.644	3.041	1.537	1.408
t-test		(0.148)	(0.385)	(0.322)	(0.726)	(0.929)	(0.734)	(0.321)	(0.045)	(0.160)	(0.219)

Table 18A: Future change in reserves (T years ahead) and current total resources – decomposed into reserves, contingent and inferred resources: including interactions with future exploration expenditure and the proportion of developed resources that are reserves (cont.).

	Pred.	T=1	T=2	T=3	T=4	T=5	T=6	T=7	T=8	T=9	T=10
*Inf.*Resv./Dev.*	?	-0.092	0.028	0.103	0.290	0.346	0.457	0.877	1.294	1.389	2.136
t-test		(0.398)	(0.851)	(0.501)	(0.162)	(0.185)	(0.111)	(0.037)	(0.031)	(0.061)	(0.061)
*Expl.*Inf.*Resv./Dev.*	+	2.648	0.634	0.599	0.339	0.116	-0.068	-1.349	-2.514	-1.007	-0.850
t-test		(0.102)	(0.314)	(0.204)	(0.532)	(0.839)	(0.933)	(0.395)	(0.073)	(0.301)	(0.382)
Acq		-0.001	0.001	0.001	-0.001	0.001	0.002	0.008	0.014	0.021	0.029
t-test		(0.633)	(0.779)	(0.721)	(0.708)	(0.793)	(0.509)	(0.100)	(0.087)	(0.041)	(0.021)
*Acq * Resv.*	+	0.121	0.250	0.179	0.243	0.423	0.855	0.891	0.788	0.726	0.366
t-test		(0.428)	(0.184)	(0.284)	(0.105)	(0.043)	(<0.001)	(<0.001)	(<0.001)	(0.035)	(0.552)
Adj. R^2		0.100	0.237	0.473	0.515	0.576	0.711	0.709	0.711	0.709	0.677
F-test		(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Obs.		493	410	344	282	226	182	144	117	93	70

All Resources variables are ounces per share. Future Reserves (Resv.) include concurrent extraction (undeflated by recovery rates). Reserves represent the economically-viable portion of Resources. Contingent (Con.) represents the economically-unviable portion of Resources. Inferred (Inf.) represents the untestable portion of Resources. Mineralised Material is Contingent plus Inferred. Developed Resources are Reserves plus Contingent. Acq is the percentage future change in the number of projects disclosing resources. Expl is the sum of future expenditure on exploration (USD, deflated by Current Reserves). Regressions include adjustments for period fixed effects. t-tests utilise White's diagonal corrected errors. p-values are two-tailed.

$$Resv_{i,t+T} - Resv_{i,t} = \beta_0 + \beta_1 Expl_{i,t+T} + \beta_2\, Resv_{i,t}/Dev_{i,t} + \beta_3 Resv_{i,t} + \beta_4 Expl_{i,t+T} * Resv_{i,t} + \beta_5 Con_{i,t} + \beta_6 Expl_{i,t+T} * Con_{i,t} + \beta_7 Inf_{i,t} + \beta_8 Expl_{i,t+T} * Inf_{i,t} + \beta_9 Inf_{i,t} * Resv_{i,t}/Dev_{i,t} + \beta_{10} Expl_{i,t+T} * Inf_{i,t} * Resv_{i,t}/Dev_{i,t} + \beta_{11} Acq_{i,t+T} + \beta_{12} Acq_{i,t+T} * Resv_{i,t} + \varepsilon_{i,t+T}$$

Table 18B: Future change in reserves (T years ahead) and current total resources – decomposed into reserves, contingent and inferred resources: including interactions with future exploration expenditure and the proportion of developed resources that are reserves (cont.).

	Pred.	T=1	T=2	T=3	T=4	T=5	T=6	T=7	T=8	T=9	T=10
Intercept		-0.001	0.000	0.002	0.004	0.007	0.010	0.023	0.034	0.031	0.032
t-test		(0.513)	(0.982)	(0.233)	(0.157)	(0.113)	(0.068)	(0.028)	(0.018)	(0.053)	(0.167)
Expl.		-0.001	0.000	0.000	0.000	0.000	0.000	-0.003	-0.005	-0.005	-0.003
t-test		(0.149)	(0.372)	(0.217)	(0.599)	(0.898)	(0.540)	(0.116)	(0.080)	(0.068)	(0.219)
Resv./Dev.		0.002	0.001	-0.004	-0.006	-0.007	-0.010	-0.020	-0.031	-0.019	-0.019
t-test		(0.265)	(0.585)	(0.142)	(0.170)	(0.256)	(0.171)	(0.096)	(0.076)	(0.372)	(0.625)
Resv.	+	-0.003	0.060	0.386	0.475	0.476	0.511	0.579	0.833	1.090	1.715
t-test		(0.939)	(0.415)	(<0.001)	(0.002)	(0.027)	(0.001)	(0.005)	(0.001)	(0.020)	(0.050)
*Expl.*Resv.*	+	4.398	4.905	3.654	3.233	2.610	1.881	1.374	0.762	0.029	-0.863
t-test		(0.035)	(0.003)	(0.001)	(0.003)	(0.004)	(0.002)	(0.059)	(0.258)	(0.970)	(0.432)
Con.	?	0.139	0.123	-0.072	-0.097	-0.024	0.107	0.084	-0.064	-0.081	-0.351
t-test		(0.092)	(0.292)	(0.530)	(0.551)	(0.916)	(0.524)	(0.720)	(0.839)	(0.863)	(0.612)
*Expl.*Con.*	+	-0.289	-0.128	0.007	-0.068	-0.096	-0.046	0.046	0.184	0.393	0.584
t-test		(0.301)	(0.213)	(0.948)	(0.546)	(0.461)	(0.772)	(0.825)	(0.364)	(0.104)	(0.073)
Inf.	0	0.065	0.034	0.062	0.000	-0.016	-0.107	-0.422	-0.646	-0.774	-1.190
t-test		(0.466)	(0.771)	(0.585)	(0.998)	(0.920)	(0.557)	(0.130)	(0.058)	(0.053)	(0.022)

Table 18B: Future change in reserves (T years ahead) and current total resources – decomposed into reserves, contingent and inferred resources: including interactions with future exploration expenditure and the proportion of developed resources that are reserves (cont.).

	Pred.	T=1	T=2	T=3	T=4	T=5	T=6	T=7	T=8	T=9	T=10
*Inf.*Resv./Dev.*	?	-0.071	0.039	0.117	0.298	0.343	0.447	0.811	1.162	1.309	2.082
t-test		(0.507)	(0.797)	(0.439)	(0.145)	(0.180)	(0.119)	(0.051)	(0.051)	(0.077)	(0.071)
*Expl.*Inf.*Resv./Dev.*	+	0.819	0.081	0.153	0.158	0.165	0.207	0.237	0.419	0.455	0.468
t-test		(0.160)	(0.607)	(0.205)	(0.264)	(0.218)	(0.029)	(0.083)	(0.007)	(0.007)	(0.010)
Acq		-0.001	0.001	0.001	-0.001	0.001	0.002	0.007	0.013	0.020	0.027
t-test		(0.606)	(0.789)	(0.759)	(0.683)	(0.777)	(0.506)	(0.126)	(0.129)	(0.051)	(0.027)
*Acq * Resv.*	+	0.121	0.251	0.180	0.244	0.422	0.853	0.903	0.813	0.738	0.359
t-test		(0.428)	(0.183)	(0.279)	(0.100)	(0.039)	(<0.001)	(<0.001)	(<0.001)	(0.034)	(0.552)
Adj. R^2		0.098	0.238	0.474	0.517	0.578	0.713	0.710	0.710	0.711	0.680
F-test		(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Obs.		493	410	344	282	226	182	144	117	93	70

All Resources variables are ounces per share. Future Reserves (Resv.) include concurrent extraction (undeflated by recovery rates). Reserves represent the economically-viable portion of Resources. Contingent (Con.) represents the economically-unviable portion of Resources. Inferred (Inf.) represents the untestable portion of Resources. Mineralised Material is Contingent plus Inferred. Developed Resources are Reserves plus Contingent. Acq is the percentage future change in the number of projects disclosing resources. Expl is the sum of future expenditure on exploration (USD, deflated by Current Reserves). Regressions include adjustments for period fixed effects. t-tests utilise White's diagonal corrected errors. p-values are two-tailed.

$$Resv_{i,t+T} - Resv_{i,t} = \beta_0 + \beta_1 Expl_{i,t+T} + \beta_2\, Resv_{i,t}/Dev_{i,t} + \beta_3 Resv_{i,t} + \beta_4 Expl_{i,t+T} * Resv_{i,t} + \beta_5 Con_{i,t} + \beta_6 Expl_{i,t+T} * Con_{i,t} + \beta_7 Inf_{i,t} + \beta_8 Inf_{i,t} * Resv_{i,t}/Dev_{i,t} + \beta_9 Expl_{i,t+T} * Inf_{i,t} * Resv_{i,t}/Dev_{i,t} + \beta_{10} Acq_{i,t+T} + \beta_{11} Acq_{i,t+T} * Resv_{i,t} + \varepsilon_{i,t+T}$$

Table 18C: Future change in reserves (T years ahead) and current total resources – decomposed into reserves, contingent and inferred resources: including interactions with current exploration expenditure and the proportion of developed resources that are reserves.

	Pred.	T=1	T=2	T=3	T=4	T=5	T=6	T=7	T=8	T=9	T=10
Intercept		0.000	0.002	0.005	0.007	0.011	0.016	0.028	0.039	0.032	0.044
t-test		(0.954)	(0.287)	(0.020)	(0.014)	(0.020)	(0.014)	(0.008)	(0.008)	(0.063)	(0.131)
Expl.		0.000	0.000	-0.001	-0.001	-0.003	-0.011	-0.060	-0.095	-0.133	-0.315
t-test		(0.601)	(0.479)	(0.425)	(0.345)	(0.307)	(0.457)	(0.027)	(0.022)	(0.052)	(0.075)
Resv./Dev.		0.002	-0.001	-0.006	-0.009	-0.010	-0.014	-0.025	-0.033	-0.007	-0.007
t-test		(0.268)	(0.776)	(0.042)	(0.049)	(0.113)	(0.078)	(0.069)	(0.100)	(0.782)	(0.881)
Resv.	+	-0.003	0.059	0.385	0.463	0.448	0.469	0.497	0.748	1.108	1.888
t-test		(0.929)	(0.413)	(<0.001)	(0.002)	(0.038)	(0.002)	(0.022)	(0.006)	(0.021)	(0.021)
*Expl.*Resv.*	+	0.366	10.460	7.127	13.010	14.744	12.820	15.180	7.521	-24.174	-46.874
t-test		(0.826)	(0.006)	(0.096)	(0.032)	(0.068)	(0.163)	(0.225)	(0.614)	(0.157)	(0.068)
Con.	?	0.145	0.127	-0.038	-0.057	0.019	0.148	0.135	0.037	0.120	-0.219
t-test		(0.081)	(0.265)	(0.747)	(0.730)	(0.935)	(0.400)	(0.583)	(0.910)	(0.789)	(0.707)
*Expl.*Con.*	+	0.476	0.466	1.394	1.363	1.498	2.426	4.891	6.190	7.339	15.302
t-test		(0.196)	(0.138)	(<0.001)	(0.004)	(0.014)	(0.004)	(<0.001)	(0.001)	(0.020)	(0.052)
Inf.	0	0.108	0.064	0.088	0.005	-0.001	-0.031	-0.220	-0.504	-0.624	-1.217
t-test		(0.237)	(0.569)	(0.452)	(0.973)	(0.996)	(0.855)	(0.525)	(0.241)	(0.175)	(0.043)
*Expl.*Inf.*	0	-2.970	-4.609	-5.319	-6.403	-7.735	-11.686	-14.974	-13.182	-7.311	-3.213
t-test		(0.024)	(<0.001)	(<0.001)	(0.005)	(0.004)	(<0.001)	(0.005)	(0.016)	(0.242)	(0.728)

Table 18C: Future change in reserves (T years ahead) and current total resources – decomposed into reserves, contingent and inferred resources: including interactions with current exploration expenditure and the proportion of developed resources that are reserves (cont.).

	Pred.	T=1	T=2	T=3	T=4	T=5	T=6	T=7	T=8	T=9	T=10
*Inf.*Resv./Dev.*	?	-0.116	0.008	0.086	0.283	0.315	0.362	0.598	0.993	1.018	1.780
t-test		(0.291)	(0.958)	(0.575)	(0.177)	(0.225)	(0.198)	(0.184)	(0.125)	(0.172)	(0.112)
*Expl.*Inf.*Resv./Dev.*	+	3.909	4.968	6.147	7.322	8.508	12.787	16.958	17.516	14.530	17.996
t-test		(0.040)	(<0.001)	(<0.001)	(0.003)	(0.002)	(<0.001)	(0.001)	(0.001)	(0.024)	(0.145)
Acq		0.000	0.001	0.002	-0.001	0.002	0.003	0.008	0.014	0.024	0.039
t-test		(0.831)	(0.721)	(0.544)	(0.861)	(0.621)	(0.391)	(0.096)	(0.095)	(0.021)	(0.002)
*Acq * Resv.*	+	0.114	0.247	0.184	0.252	0.435	0.879	0.952	0.847	0.699	0.165
t-test		(0.459)	(0.188)	(0.271)	(0.092)	(0.036)	(<0.001)	(<0.001)	(<0.001)	(0.052)	(0.770)
Adj. R^2		0.081	0.225	0.454	0.502	0.565	0.704	0.705	0.702	0.713	0.704
F-test		(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Obs.		493	410	344	282	226	182	144	117	93	70

All Resources variables are ounces per share. Future Reserves (Resv.) include concurrent extraction (undeflated by recovery rates). Reserves represent the economically-viable portion of Resources. Contingent (Con.) represents the economically-unviable portion of Resources. Inferred (Inf.) represents the untestable portion of Resources. Mineralised Material is Contingent plus Inferred. Developed Resources are Reserves plus Contingent. Acq is the percentage future change in the number of projects disclosing resources. Expl is current expenditure on exploration (USD, deflated by Current Reserves). Regressions include adjustments for period fixed effects. t-tests utilise White's diagonal corrected errors. p-values are two-tailed.

$$Resv_{i,t+T} - Resv_{i,t} = \beta_0 + \beta_1 Expl_{i,t} + \beta_2 Resv_{i,t}/Dev_{i,t} + \beta_3 Resv_{i,t} + \beta_4 Expl_{i,t} * Resv_{i,t} + \beta_5 Con_{i,t} + \beta_6 Expl_{i,t} * Con_{i,t} + \beta_7 Inf_{i,t} + \beta_8 Expl_{i,t} * Inf_{i,t} + \beta_9 Inf_{i,t} * Resv_{i,t}/Dev_{i,t} + \beta_{10} Expl_{i,t} * Inf_{i,t} * Resv_{i,t}/Dev_{i,t} + \beta_{11} Acq_{i,t+T} + \beta_{12} Acq_{i,t+T} * Resv_{i,t} + \varepsilon_{i,t+T}$$

Table 19: Market value and decomposed current total resources: including interactions with exploration expenditure and the proportion of developed resources that are reserves.

	Pred.	Panel i JORC & NI 43-101	Panel ii JORC & NI 43-101
Intercept		-0.521	1.929
t-test		(0.523)	(0.021)
Expl.		-0.534	-5.042
t-test		(0.835)	(0.126)
Resv./Dev.			-3.205
t-test			(0.020)
SResv.	+	0.305	0.347
t-test		(<0.001)	(<0.001)
*Expl.**SResv.*	?	0.355	2.339
t-test		(0.947)	(0.681)
Con.	+	-0.075	-0.227
t-test		(0.295)	(0.047)
*Expl.**SCon.*	+	4.470	4.259
t-test		(0.165)	(0.169)
Inf.	0	-0.037	0.177
t-test		(0.431)	(0.233)
*Expl.**SInf.*	+	-0.529	-3.232
t-test		(0.460)	(0.099)
*SInf.**Resv./Dev.*	?		-0.292
t-test			(0.167)
*Expl.**SInf.**Resv./Dev.*	+		4.528
t-test			(0.082)

Table 19: Market value and decomposed current total resources: including interactions with exploration expenditure and the proportion of developed resources that are reserves (cont.).

	Pred.	Panel i JORC & NI 43-101	Panel ii JORC & NI 43-101
SBypr.	+	-0.103	-0.092
t-test		(0.010)	(0.019)
BVEa	+	1.803	1.679
t-test		(0.002)	(0.003)
Sunk	+	1.352	1.313
t-test		(<0.001)	(<0.001)
CapEx.	+	1.789	1.233
t-test		(0.152)	(0.286)
Adj. R^2		0.901	0.906
F-test		(<0.001)	(<0.001)
Obs.		321	321

All variables are in USD per share. All Resources variables are multiplied by the USD spot price. Market value of equity (MVE) is the stock price six months after the financial year end. Reserves (Resv.) represent the economically-viable portion of Resources. Contingent (Con.) represents the economically-unviable portion of Resources. Inferred (Inf.) represents the untestable portion of Resources. Mineralised Material is Contingent plus Inferred. Developed Resources (Dev.) are Reserves plus Contingent. Bypr is commodities other than gold (total resources). BVEa is the book value of ordinary equity minus Sunk and CapEx. Sunk is the book value of property, plant and equipment, and intangible assets. CapEx is the expected future expenditure on Sunk (from the feasibility report). Expl. is the current expenditure on exploration (USD, deflated by Current Reserves). Regressions include adjustments for cross-sectional and period fixed effects. t-tests utilise White's diagonal corrected errors. p-values are two-tailed.

Panel i: $MVE_{i,t} = \beta_0 + \beta_1 Expl_{i,t} + \beta_2 SResv_{i,t} + \beta_3 Expl_{i,t} * SResv_{i,t} + \beta_4 SCon_{i,t} + \beta_5 Expl_{i,t} * SCon_{i,t} + \beta_6 SInf_{i,t} + \beta_7 Expl_{i,t} * SInf_{i,t} + \beta_8 SBypr_{i,t} + \beta_9 BVEa_{i,t} + \beta_{10} Sunk_{i,t} + \beta_{11} CapEx_{i,t} + \varepsilon_{i,t}$

Panel ii: $MVE_{i,t} = \beta_0 + \beta_1 Expl_{i,t} + \beta_2\, Resv_{i,t}/Dev_{i,t} + \beta_3 SResv_{i,t} + \beta_4 Expl_{i,t} * SResv_{i,t} + \beta_5 SCon_{i,t} + \beta_6 Expl_{i,t} * SCon_{i,t} + \beta_7 SInf_{i,t} + \beta_8 SInf_{i,t} + \beta_9 SInf_{i,t} * Resv_{i,t}/Dev_{i,t} + \beta_{10} Expl_{i,t} * SInf_{i,t} * Resv_{i,t}/Dev_{i,t} + \beta_{11} SBypr_{i,t} + \beta_{12} BVEa_{i,t} + \beta_{13} Sunk_{i,t} + \beta_{14} CapEx_{i,t} + \varepsilon_{i,t}$

Table 20: The proportion of mineralised material that is inferred resources, and exploration expenditure.

	Pred.	JORC & NI 43-101	JORC & NI 43-101
Intercept		0.589	0.587
t-test		(<0.001)	(<0.001)
Devpr	+	0.162	0.163
t-test		(0.009)	(0.008)
Expl.	+	0.051	
t-test		(0.427)	
*Devpr * Expl.*	+	0.122	0.173
t-test		(0.266)	(0.049)
Resv. / Resc.	-	-0.090	-0.095
t-test		(0.237)	(0.214)
*Devpr * Resv./Resc.*	-	-0.247	-0.244
t-test		(0.077)	(0.081)
Prod.	-	-0.014	0.032
t-test		(0.918)	(0.807)
Adj. R^2		0.097	0.096
F-test		(<0.001)	(<0.001)
Obs.		554	554

All variables are in ounces per share. Reserves (Resv.) represent the economically-viable portion of Resources (Resc.). Contingent represents the economically-unviable portion of Resources. Inferred represents the untestable portion of Resources. Mineralised Material is Contingent plus Inferred. Devpr is an indicator variable for firms with zero current production. Expl is the current expenditure on exploration (USD, deflated by Current Reserves). Prod is the ounces of current production deflated by the sum of current production and reserves. Regressions include adjustments for period fixed effects. t-tests utilise White's diagonal corrected errors. p-values are two-tailed.

Panel A: $Inf_{i,t}/MinMat_{i,t} = \beta_0 + \beta_1 Devpr_{i,t} + \beta_2 Expl_{i,t} + \beta_3 Devpr_{i,t} * Expl_{i,t} + \beta_4 Resv_{i,t}/Resc_{i,t} + \beta_5 Devpr_{i,t} * Resv_{i,t}/Resc_{i,t} + \beta_6 Prod_{i,t} + \varepsilon_{i,t+T}$

Table 21A: The proportion of mineralised material that is inferred resources, and lagged change in gold price.

	Pred.	T=1	T=2	T=3	T=4	T=5	T=6	T=7	T=8	T=9	T=10
Intercept		0.656	0.664	0.667	0.672	0.670	0.668	0.666	0.664	0.662	0.662
t-test		(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Devpr	+	0.073	0.064	0.061	0.054	0.053	0.057	0.062	0.066	0.070	0.074
t-test		(0.260)	(0.338)	(0.364)	(0.428)	(0.432)	(0.398)	(0.353)	(0.323)	(0.292)	(0.263)
GoldMove	+	-0.203	-0.135	-0.092	-0.070	-0.053	-0.041	-0.034	-0.030	-0.030	-0.032
t-test		(0.029)	(0.024)	(0.018)	(0.018)	(0.028)	(0.046)	(0.059)	(0.079)	(0.075)	(0.069)
*Devpr * GoldMove*	+	0.322	0.193	0.139	0.110	0.096	0.074	0.058	0.051	0.048	0.039
t-test		(0.096)	(0.095)	(0.074)	(0.061)	(0.039)	(0.060)	(0.098)	(0.128)	(0.160)	(0.269)
Resv./Resc.	-	-0.146	-0.145	-0.146	-0.152	-0.153	-0.155	-0.156	-0.156	-0.156	-0.156
t-test		(0.069)	(0.070)	(0.067)	(0.055)	(0.052)	(0.051)	(0.050)	(0.050)	(0.050)	(0.050)
*Devpr * Resv./Resc.*	-	-0.236	-0.237	-0.239	-0.233	-0.234	-0.231	-0.227	-0.224	-0.223	-0.222
t-test		(0.100)	(0.096)	(0.093)	(0.099)	(0.095)	(0.100)	(0.108)	(0.113)	(0.116)	(0.120)
Prod.	-	-0.074	-0.089	-0.095	-0.109	-0.108	-0.109	-0.110	-0.108	-0.107	-0.108
t-test		(0.567)	(0.504)	(0.479)	(0.421)	(0.427)	(0.423)	(0.420)	(0.427)	(0.430)	(0.423)
Adj. R^2		0.032	0.033	0.034	0.034	0.034	0.032	0.030	0.029	0.029	0.029
F-test		(0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Obs.		554	554	554	554	554	554	554	554	554	554

All variables are in ounces per share. Reserves (Resv) represent the economically-viable portion of Resources (Resc). Contingent represents the economically-unviable portion of Resources. Inferred represents the untestable portion of Resources. Mineralised Material is Contingent plus Inferred. Devpr is an indicator variable for firms with zero current production. GoldMove is the percentage lagged change in the spot price of gold (USD). Pos (Neg) Gold is the piece-wise positive (negative) decomposition of GoldMove. Prod is the amount of current production deflated by the sum of current production and reserves. t-tests utilise White's diagonal corrected errors. p-values are two-tailed.

$$Inf_{i,t}/MinMat_{i,t} = \beta_0 + \beta_1 Devpr_{i,t} + \beta_2 GoldMove_{i,t-T} + \beta_3 Devpr_{i,t} * GoldMove_{i,t-T} + \beta_4\, Resv_{i,t}/Resc_{i,t} + \beta_5 Devpr_{i,t} * Resv_{i,t}/Resc_{i,t} + \beta_6 Prod_{i,t} + \varepsilon_{i,t+T}$$

Table 21B: The proportion of mineralised material that is inferred resources, and lagged change in gold price decomposed into positive and negative changes.

	Pred.	T=1	T=2	T=3	T=4	T=5	T=6	T=7	T=8	T=9	T=10
Intercept		0.617	0.633	0.615	0.626	0.653	0.636	0.651	0.660	0.605	0.617
t-test		(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Devpr	+	0.090	0.058	0.090	0.097	0.060	0.089	0.071	0.077	0.140	0.131
t-test		(0.209)	(0.495)	(0.310)	(0.290)	(0.499)	(0.309)	(0.415)	(0.360)	(0.095)	(0.087)
PosGold	+	-0.021	-0.062	-0.021	-0.024	-0.039	-0.019	-0.025	-0.028	-0.001	-0.008
t-test		(0.855)	(0.488)	(0.714)	(0.582)	(0.229)	(0.492)	(0.295)	(0.206)	(0.957)	(0.708)
*Devpr * PosGold*	+	0.257	0.222	0.106	0.067	0.093	0.053	0.053	0.044	0.012	0.007
t-test		(0.279)	(0.198)	(0.363)	(0.454)	(0.178)	(0.351)	(0.274)	(0.316)	(0.790)	(0.858)
NegGold	+	-0.792	-0.367	-0.393	-0.297	-0.146	-0.231	-0.128	-0.050	-0.339	-0.263
t-test		(0.022)	(0.133)	(0.057)	(0.101)	(0.383)	(0.195)	(0.502)	(0.790)	(0.045)	(0.052)
*Devpr * NegGold*	+	0.446	0.042	0.268	0.321	0.124	0.261	0.109	0.122	0.438	0.342
t-test		(0.518)	(0.930)	(0.518)	(0.381)	(0.708)	(0.455)	(0.758)	(0.717)	(0.176)	(0.175)
Resv./Resc.	-	-0.142	-0.138	-0.133	-0.140	-0.149	-0.150	-0.154	-0.156	-0.144	-0.143
t-test		(0.076)	(0.085)	(0.099)	(0.081)	(0.060)	(0.059)	(0.053)	(0.052)	(0.073)	(0.074)
*Devpr * Resv./Resc.*	-	-0.238	-0.243	-0.251	-0.245	-0.237	-0.236	-0.227	-0.226	-0.240	-0.238
t-test		(0.096)	(0.087)	(0.079)	(0.085)	(0.093)	(0.095)	(0.109)	(0.112)	(0.095)	(0.098)
Prod.	-	-0.076	-0.077	-0.076	-0.089	-0.101	-0.102	-0.107	-0.107	-0.091	-0.090
t-test		(0.552)	(0.558)	(0.566)	(0.512)	(0.457)	(0.458)	(0.432)	(0.429)	(0.502)	(0.503)
Adj. R^2		0.037	0.034	0.035	0.034	0.031	0.030	0.027	0.026	0.031	0.031
F-test		(<0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.003)	(0.004)	(0.001)	(0.001)
Obs.		554	554	554	554	554	554	554	554	554	554

All variables are in ounces per share. Reserves (Resv) represent the economically-viable portion of Resources (Resc). Contingent represents the economically-unviable portion of Resources. Inferred represents the untestable portion of Resources. Mineralised Material is Contingent plus Inferred. Devpr is an indicator variable for firms with zero current production. GoldMove is the percentage lagged change in the spot price of gold (USD). Pos (Neg) Gold is the piece-wise positive (negative) decomposition of GoldMove. Prod is the amount of current production deflated by the sum of current production and reserves. t-tests utilise White's diagonal corrected errors. p-values are two-tailed.

$$Inf_{i,t}/MinMat_{i,t} = \beta_0 + \beta_1 Devpr_{i,t} + \beta_2 PosGold_{i,t-T} + \beta_3 NegGold_{i,t-T} + \beta_4 Devpr_{i,t} * PosGold_{i,t-T} + \beta_5 Devpr_{i,t} * NegGold_{i,t-T} + \beta_6\, Resv_{i,t}/Resc_{i,t} + \beta_7 Devpr_{i,t} * Resv_{i,t}/Resc_{i,t} + \beta_8 Prod_{i,t} + \varepsilon_{i,t+T}$$

Table 22A: Future Change in reserves (T years ahead) and decomposed current developed resources: including interactions with future change in gold price - decomposed into positive and negative changes - t = 1995-2000.

	Pred.	T=1	T=2	T=3	T=4	T=5	T=6	T=7	T=8	T=9	T=10
Intercept		0.002	0.000	0.003	0.003	0.001	0.007	0.016	0.015	0.015	0.012
t-test		(0.243)	(0.796)	(0.340)	(0.425)	(0.737)	(0.133)	(0.030)	(0.040)	(0.045)	(0.352)
Pos GoldMove		-0.023	-0.024	-0.021	-0.003	0.010	0.002	-0.005	0.000	0.002	0.010
t-test		(0.275)	(0.793)	(0.231)	(0.813)	(0.425)	(0.795)	(0.526)	(0.940)	(0.685)	(0.414)
Neg GoldMove		0.003	-0.012	-0.006	-0.013	-0.031	0.006	0.096	-0.012		
t-test		(0.879)	(0.343)	(0.687)	(0.496)	(0.165)	(0.808)	(0.157)	(0.913)		
Resv.	+	0.003	0.125	0.276	0.514	0.558	0.576	0.801	1.274	1.678	2.201
t-test		(0.982)	(0.364)	(0.028)	(0.088)	(0.246)	(0.015)	(<0.001)	(<0.001)	(0.001)	(0.006)
*Pos Gold*Rsv*	0	1.289	13.493	0.712	0.411	0.026	-0.192	-0.418	-0.542	-0.579	-0.477
t-test		(0.819)	(0.426)	(0.530)	(0.580)	(0.981)	(0.577)	(0.192)	(0.024)	(0.065)	(0.356)
*Neg Gold*Rsv*	+	0.285	0.543	0.172	1.125	1.099	-3.286	-7.390	73.360		
t-test		(0.645)	(0.660)	(0.858)	(0.426)	(0.605)	(0.002)	(0.004)	(0.018)		
Contingent	0	-0.057	-0.004	-0.222	-0.268	-0.274	-0.087	-0.375	-0.544	-0.633	-0.643
t-test		(0.595)	(0.982)	(0.469)	(0.491)	(0.630)	(0.795)	(0.286)	(0.043)	(0.102)	(0.355)
*Pos Gold*Con*	+	2.993	-13.664	2.633	0.883	0.993	0.900	1.297	1.146	1.097	0.576
t-test		(0.492)	(0.307)	(0.147)	(0.379)	(0.413)	(0.138)	(0.003)	(0.002)	(0.001)	(0.063)

Table 22A: Future Change in reserves (T years ahead) and decomposed current developed resources: including interactions with future change in gold price - decomposed into positive and negative changes - t = 1995-2000 (cont.).

	Pred.	T=1	T=2	T=3	T=4	T=5	T=6	T=7	T=8	T=9	T=10
*Neg Gold*Con*	0	-1.834	-1.037	-0.967	-0.963	-0.777	1.473	0.574	-9.196		
t-test		(0.002)	(0.350)	(0.497)	(0.571)	(0.718)	(0.236)	(0.852)	(0.030)		
Acq		0.000	0.004	0.002	0.001	0.000	0.007	0.011	0.018	0.023	0.033
t-test		(0.858)	(0.307)	(0.554)	(0.744)	(0.926)	(0.022)	(0.020)	(0.057)	(0.054)	(0.031)
*Acq * Resv.*	+	0.204	0.527	0.373	0.252	0.544	0.905	1.087	1.041	1.096	0.701
t-test		(0.445)	(0.073)	(0.133)	(0.388)	(0.070)	(<0.001)	(0.001)	(0.001)	(0.010)	(0.397)
Adj. R^2		0.028	0.196	0.359	0.382	0.419	0.647	0.656	0.666	0.716	0.639
F-test		(0.118)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Obs.		196	181	167	146	132	121	110	101	93	70

All Resources variables are ounces per share. Future Reserves (Resv.) include concurrent extraction (undeflated by recovery rates). Reserves represent the economically-viable portion of Resources. Contingent (Con.) represents the economically-unviable portion of Resources. Inferred represents the untestable portion of Resources. Mineralised Material is Contingent plus Inferred. Developed Resources are Reserves plus Contingent. Acq is the percentage future change in the number of projects disclosing resources. GoldMove is the percentage future change in the spot price of gold (USD). Pos (Neg) Gold is the piece-wise positive (negative) decomposition of GoldMove. t-tests utilise White's diagonal corrected errors. p-values are two-tailed.

$$Resv_{i,t+T} - Resv_{i,t} = \beta_0 + \beta_1 PosGold_{i,t+T} + \beta_2 NegGold_{i,t+T} + \beta_3 Resv_{i,t} + \beta_4 PosGold_{i,t+T} * Resv_{i,t} + \beta_5 NegGold_{i,t+T} * Resv_{i,t} + \beta_6 Con_{i,t} + \beta_7 PosGold_{i,t+T} * Con_{i,t} + \beta_8 NegGold_{i,t+T} * Con_{i,t} + \beta_9 Acq_{i,t+T} + \beta_{10} Acq_{i,t+T} * Resv_{i,t} + \varepsilon_{i,t+T}$$

Table 22B: Future Change in reserves (T years ahead) and decomposed current developed resources: including interactions with future change in gold price - decomposed into positive and negative changes - t = 2001-2008.

	Pred.	T=1	T=2	T=3	T=4	T=5	T=6	T=7	T=8
Intercept		0.001	-0.003	0.005	0.001	-0.002	-0.009	0.003	0.829
t-test		(0.356)	(0.134)	(0.148)	(0.753)	(0.711)	(0.590)	(0.883)	(0.161)
Pos GoldMove		0.002	0.015	-0.005	0.001	0.005	0.010	0.005	-0.373
t-test		(0.555)	(0.027)	(0.178)	(0.684)	(0.361)	(0.378)	(0.664)	(0.162)
Neg GoldMove		0.016							
t-test		(0.272)							
Resv.	+	0.022	0.324	0.456	0.601	0.764	1.132	-1.692	25.133
t-test		(0.709)	(0.157)	(0.343)	(0.227)	(0.215)	(0.337)	(0.591)	(0.674)
*Pos Gold*Rsv*	0	-0.219	-0.483	0.242	0.167	0.010	-0.429	0.721	-11.508
t-test		(0.260)	(0.355)	(0.710)	(0.777)	(0.986)	(0.483)	(0.630)	(0.670)
*Neg Gold*Rsv*	+	0.597							
t-test		(0.578)							
Contingent	0	0.187	0.720	0.018	0.485	1.231	0.803	7.468	-1551.039
t-test		(0.084)	(0.026)	(0.977)	(0.562)	(0.280)	(0.659)	(0.817)	(0.194)
*Pos Gold*Con*	+	0.578	-1.127	0.279	-0.252	-0.484	0.083	-2.744	714.791
t-test		(0.392)	(0.242)	(0.798)	(0.811)	(0.583)	(0.943)	(0.859)	(0.193)

Table 22B: Future Change in reserves (T years ahead) and decomposed current developed resources: including interactions with future change in gold price - decomposed into positive and negative changes - t = 2001-2008 (cont.).

	Pred.	T=1	T=2	T=3	T=4	T=5	T=6	T=7	T=8
*Neg Gold*Con*	0	1.921							
t-test		(0.317)							
Acq		-0.003	-0.004	0.004	0.008	0.024	0.012	0.005	0.026
t-test		(0.263)	(0.287)	(0.575)	(0.396)	(0.025)	(0.284)	(0.751)	(0.401)
*Acq * Resv.*	+	0.149	0.241	-0.015	0.033	0.038	0.772	1.384	1.097
t-test		(0.358)	(0.191)	(0.939)	(0.843)	(0.840)	(0.058)	(0.003)	(0.283)
Adj. R^2		0.141	0.296	0.552	0.596	0.692	0.760	0.789	0.807
F-test		(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(0.002)
Obs.		196	181	167	146	132	121	110	101

All Resources variables are ounces per share. Future Reserves (Resv.) include concurrent extraction (undeflated by recovery rates). Reserves represent the economically-viable portion of Resources. Contingent (Con.) represents the economically-unviable portion of Resources. Inferred represents the untestable portion of Resources. Mineralised Material is Contingent plus Inferred. Developed Resources are Reserves plus Contingent. Acq is the percentage future change in the number of projects disclosing resources. GoldMove is the percentage future change in the spot price of gold (USD). Pos (Neg) Gold is the piece-wise positive (negative) decomposition of GoldMove. t-tests utilise White's diagonal corrected errors. p-values are two-tailed.

$$\begin{aligned} Resv_{i,t+T} - Resv_{i,t} &= \beta_0 + \beta_1 PosGold_{i,t+T} + \beta_2 NegGold_{i,t+T} + \beta_3 Resv_{i,t} + \beta_4 PosGold_{i,t+T} * Resv_{i,t} + \beta_5 NegGold_{i,t+T} * Resv_{i,t} \\ &+ \beta_6 Con_{i,t} + \beta_7 PosGold_{i,t+T} * Con_{i,t} + \beta_8 NegGold_{i,t+T} * Con_{i,t} + \beta_9 Acq_{i,t+T} + \beta_{10} Acq_{i,t+T} * Resv_{i,t} + \varepsilon_{i,t+T} \end{aligned}$$

Table 22C: Future change in reserves (T years ahead) and current total resources decomposed into reserves, contingent and inferred resources: including interactions with future exploration expenditure and the proportion of reserves to developed resources - t = 1995-2000.

	Pred.	T=1	T=2	T=3	T=4	T=5	T=6	T=7	T=8	T=9	T=10
Intercept		0.002	0.003	0.006	0.007	0.008	0.012	0.020	0.030	0.031	0.032
t-test		(0.223)	(0.176)	(0.013)	(0.050)	(0.143)	(0.023)	(0.014)	(0.015)	(0.053)	(0.167)
Expl.		-0.002	0.000	-0.001	-0.001	0.000	-0.001	-0.003	-0.004	-0.005	-0.003
t-test		(0.289)	(0.470)	(0.050)	(0.201)	(0.793)	(0.357)	(0.118)	(0.087)	(0.068)	(0.219)
Resv./Dev.		-0.002	-0.004	-0.008	-0.010	-0.010	-0.014	-0.019	-0.028	-0.019	-0.019
t-test		(0.423)	(0.202)	(0.023)	(0.096)	(0.227)	(0.096)	(0.094)	(0.097)	(0.372)	(0.625)
Resv.	+	-0.017	0.042	0.249	0.295	0.315	0.535	0.678	0.866	1.090	1.715
t-test		(0.840)	(0.733)	(0.009)	(0.102)	(0.254)	(0.003)	(0.014)	(0.002)	(0.020)	(0.050)
*Expl.*Resv.*	+	1.384	3.216	2.564	2.846	2.508	1.425	1.421	0.835	0.029	-0.863
t-test		(0.621)	(0.036)	(0.012)	(0.006)	(0.004)	(0.041)	(0.043)	(0.241)	(0.970)	(0.432)
Con.	?	0.089	0.068	-0.117	-0.133	-0.087	0.005	-0.118	-0.189	-0.081	-0.351
t-test		(0.408)	(0.568)	(0.296)	(0.408)	(0.768)	(0.982)	(0.677)	(0.541)	(0.863)	(0.612)
*Expl.*Con.*	+	-0.003	-0.072	0.175	0.087	0.009	0.083	0.207	0.293	0.393	0.584
t-test		(0.987)	(0.187)	(0.015)	(0.345)	(0.953)	(0.408)	(0.189)	(0.125)	(0.104)	(0.073)
Inf.	0	-0.043	-0.028	-0.048	-0.161	-0.195	-0.338	-0.533	-0.708	-0.774	-1.190
t-test		(0.590)	(0.817)	(0.667)	(0.267)	(0.307)	(0.081)	(0.048)	(0.035)	(0.053)	(0.022)

Table 22C: Future change in reserves (T years ahead) and current total resources decomposed into reserves, contingent and inferred resources: including interactions with future exploration expenditure and the proportion of reserves to developed resources - t = 1995-2000 (cont.).

	Pred.	T=1	T=2	T=3	T=4	T=5	T=6	T=7	T=8	T=9	T=10
*Inf.*Resv./Dev.*	?	0.026	0.082	0.185	0.451	0.560	0.744	1.039	1.337	1.309	2.082
t-test		(0.787)	(0.575)	(0.218)	(0.051)	(0.073)	(0.031)	(0.032)	(0.046)	(0.077)	(0.071)
*Expl.*Inf.*Resv./Dev.*	+	1.604	0.269	0.311	0.203	0.153	0.214	0.181	0.375	0.455	0.468
t-test		(<0.001)	(0.087)	(0.005)	(0.174)	(0.274)	(0.022)	(0.166)	(0.013)	(0.007)	(0.010)
Acq		0.000	0.002	0.001	-0.003	-0.002	0.003	0.008	0.012	0.020	0.027
t-test		(0.868)	(0.683)	(0.848)	(0.521)	(0.660)	(0.392)	(0.126)	(0.136)	(0.051)	(0.027)
*Acq * Resv.*	+	0.164	0.664	0.449	0.492	0.630	0.881	0.783	0.719	0.738	0.359
t-test		(0.543)	(0.008)	(0.039)	(0.076)	(0.054)	(<0.001)	(0.002)	(0.001)	(0.034)	(0.552)
Adj. R^2		0.077	0.213	0.395	0.414	0.454	0.655	0.677	0.683	0.711	0.680
F-test		(0.022)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Obs.		196	181	167	146	132	121	110	101	93	70

All Resources variables are ounces per share. Future Reserves (Resv.) include concurrent extraction (undeflated by recovery rates). Reserves represent the economically-viable portion of Resources. Contingent (Con.) represents the economically-unviable portion of Resources. Inferred (Inf.) represents the untestable portion of Resources. Mineralised Material is Contingent plus Inferred. Developed Resources are Reserves plus Contingent. Acq is the percentage future change in the number of projects disclosing resources. Expl is the sum of future expenditure on exploration (USD, deflated by Current Reserves). Regressions include adjustments for period fixed effects. t-tests utilise White's diagonal corrected errors. p-values are two-tailed.

$$Resv_{i,t+T} - Resv_{i,t} = \beta_0 + \beta_1 Expl_{i,t+T} + \beta_2 Resv_{i,t}/Dev_{i,t} + \beta_3 Resv_{i,t} + \beta_4 Expl_{i,t+T} * Resv_{i,t} + \beta_5 Con_{i,t} + \beta_6 Expl_{i,t+T} * Con_{i,t} + \beta_7 Inf_{i,t} + \beta_8 Inf_{i,t} * Resv_{i,t}/Dev_{i,t} + \beta_9 Expl_{i,t+T} * Inf_{i,t} * Resv_{i,t}/Dev_{i,t} + \beta_{10} Acq_{i,t+T} + \beta_{11} Acq_{i,t+T} * Resv_{i,t} + \varepsilon_{i,t+T}$$

Table 22D: Future change in reserves (T years ahead) and current total resources decomposed into reserves, contingent and inferred resources: including interactions with future exploration expenditure and the proportion of reserves to developed resources - t = 2001-2008.

	Pred.	T=1	T=2	T=3	T=4	T=5	T=6	T=7	T=8
Intercept		-0.002	-0.001	0.001	0.003	-0.002	0.015	-0.005	-0.002
t-test		(0.262)	(0.520)	(0.794)	(0.451)	(0.712)	(0.238)	(0.837)	(0.904)
Expl.		0.000	0.000	0.000	0.000	0.001	-0.005	-0.001	-0.004
t-test		(0.461)	(0.587)	(0.871)	(0.628)	(0.079)	(0.287)	(0.925)	(0.471)
Resv./Dev.		0.003	0.004	-0.004	-0.006	0.005	-0.013	0.007	0.012
t-test		(0.172)	(0.210)	(0.381)	(0.290)	(0.522)	(0.336)	(0.772)	(0.721)
Resv.	+	-0.014	0.027	0.609	0.763	0.708	-0.183	-0.982	-2.389
t-test		(0.660)	(0.783)	(0.001)	(<0.001)	(<0.001)	(0.642)	(0.139)	(0.042)
*Expl.*Resv.*	+	9.397	7.660	4.760	3.494	1.948	6.952	9.122	9.320
t-test		(0.036)	(0.022)	(0.005)	(0.030)	(0.198)	(<0.001)	(<0.001)	(0.004)
Con.	?	0.164	0.253	-0.150	-0.148	0.545	1.652	1.000	5.596
t-test		(0.085)	(0.165)	(0.503)	(0.640)	(0.150)	(0.051)	(0.627)	(0.290)
*Expl.*Con.*	+	-1.859	-1.160	-0.240	-0.204	-0.243	-2.958	-3.033	-4.593
t-test		(0.232)	(0.290)	(0.241)	(0.241)	(0.254)	(0.001)	(0.021)	(0.079)
Inf.	0	0.153	0.025	0.182	0.188	-0.152	-0.952	9.363	5.100
t-test		(0.333)	(0.920)	(0.516)	(0.602)	(0.716)	(0.233)	(0.267)	(0.683)

Table 22D: Future change in reserves (T years ahead) and current total resources decomposed into reserves, contingent and inferred resources: including interactions with future exploration expenditure and the proportion of reserves to developed resources - t = 2001-2008 (cont.).

	Pred.	T=1	T=2	T=3	T=4	T=5	T=6	T=7	T=8
*Inf.**Resv./Dev.*	?	-0.109	0.112	0.148	0.215	0.432	1.129	-9.260	-5.171
t-test		(0.552)	(0.727)	(0.696)	(0.673)	(0.467)	(0.200)	(0.270)	(0.676)
*Expl.*Inf.*Resv./Dev.*	+	-0.264	-0.061	0.000	-0.023	-0.061	0.246	-2.811	-2.576
t-test		(0.198)	(0.769)	(0.998)	(0.884)	(0.862)	(0.538)	(0.068)	(0.095)
Acq		-0.003	-0.005	0.002	0.005	0.023	-0.002	-0.004	0.018
t-test		(0.395)	(0.346)	(0.713)	(0.588)	(0.024)	(0.836)	(0.835)	(0.575)
*Acq * Resv.*	+	0.130	0.253	-0.082	-0.037	-0.034	1.067	1.661	1.919
t-test		(0.423)	(0.177)	(0.709)	(0.838)	(0.858)	(0.001)	(0.001)	(0.038)
Adj. R^2		0.161	0.291	0.576	0.614	0.694	0.795	0.864	0.986
F-test		(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(0.012)
Obs.		196	181	167	146	132	121	110	101

All Resources variables are ounces per share. Future Reserves (Resv.) include concurrent extraction (undeflated by recovery rates). Reserves represent the economically-viable portion of Resources. Contingent (Con.) represents the economically-unviable portion of Resources. Inferred (Inf.) represents the untestable portion of Resources. Mineralised Material is Contingent plus Inferred. Developed Resources are Reserves plus Contingent. Acq is the percentage future change in the number of projects disclosing resources. Expl is the sum of future expenditure on exploration (USD, deflated by Current Reserves). Regressions include adjustments for period fixed effects. t-tests utilise White's diagonal corrected errors. p-values are two-tailed.

$$Resv_{i,t+T} - Resv_{i,t} = \beta_0 + \beta_1 Expl_{i,t+T} + \beta_2 Resv_{i,t}/Dev_{i,t} + \beta_3 Resv_{i,t} + \beta_4 Expl_{i,t+T} * Resv_{i,t} + \beta_5 Con_{i,t} + \beta_6 Expl_{i,t+T} * Con_{i,t} + \beta_7 Inf_{i,t} + \beta_8 Inf_{i,t} * Resv_{i,t}/Dev_{i,t} + \beta_9 Expl_{i,t+T} * Inf_{i,t} * Resv_{i,t}/Dev_{i,t} + \beta_{10} Acq_{i,t+T} + \beta_{11} Acq_{i,t+T} * Resv_{i,t} + \varepsilon_{i,t+T}$$

Table 22E: Market value and current total resources decomposed into reserves and contingent resources: including interactions with lagged change in gold price - decomposed into positive and negative changes - t = 1995-2000.

	Pred.	T=1	T=2	T=3	T=4	T=5	T=6	T=7	T=8	T=9	T=10
Intercept		0.913	2.255	2.045	2.202	1.880	1.768	1.823	2.802	1.864	1.722
t-test		(0.020)	(0.010)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(0.002)	(0.005)
PosGold		-4.245	-88.292	1.374	-3.345	-0.255	0.044	-3.511			
t-test		(0.225)	(0.248)	(0.675)	(0.417)	(0.955)	(0.992)	(0.796)			
NegGold		0.629	1.109	1.627	2.189	1.299	2.311	2.363	1.647	1.024	0.685
t-test		(0.552)	(0.505)	(0.103)	(0.213)	(0.117)	(0.026)	(0.029)	(0.280)	(0.227)	(0.087)
SResv.	+	0.345	0.113	0.086	0.096	0.071	0.080	0.092	0.101	0.410	0.181
t-test		(<0.001)	(0.216)	(0.241)	(0.090)	(0.153)	(0.197)	(0.054)	(0.129)	(0.009)	(0.025)
*PosGold*SResv.*	0	-2.589	15.029	15.364	1.050	3.693	1.712	5.273			
t-test		(<0.001)	(0.782)	(0.014)	(<0.001)	(<0.001)	(<0.001)	(<0.001)			
*NegGold*SResv.*	+	1.753	0.163	0.096	0.342	0.271	0.284	0.404	0.479	1.519	0.411
t-test		(<0.001)	(0.702)	(0.655)	(0.049)	(0.005)	(0.114)	(0.001)	(0.104)	(0.020)	(<0.001)
SCon.	0	-0.253	-0.067	0.111	0.431	0.268	0.038	0.200	0.271	-0.332	-0.112
t-test		(0.090)	(0.497)	(0.422)	(0.158)	(0.100)	(0.804)	(0.291)	(0.313)	(0.205)	(0.141)
*PosGold*SCon.*	+	2.085	-49.144	-32.263	-3.314	-5.168	-0.477	-3.433			
t-test		(0.193)	(0.573)	(0.016)	(0.159)	(0.155)	(0.739)	(0.516)			
*NegGold*SCon.*	0	-1.272	0.623	1.501	2.131	1.355	0.397	1.150	2.090	-1.050	0.035
t-test		(0.174)	(0.465)	(0.031)	(0.087)	(0.038)	(0.493)	(0.171)	(0.127)	(0.374)	(0.864)
SBypr.	+	-0.080	-0.104	-0.096	-0.103	-0.101	-0.085	-0.093	-0.110	-0.094	-0.094
t-test		(0.001)	(0.027)	(0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(0.001)	(0.013)	(0.015)

Table 22E: Market value and current total resources decomposed into reserves and contingent resources: including interactions with lagged change in gold price - decomposed into positive and negative changes - t = 1995-2000 (cont.).

	Pred.	T=1	T=2	T=3	T=4	T=5	T=6	T=7	T=8	T=9	T=10
BVE	+	0.996	1.070	0.747	0.560	0.588	0.789	0.676	1.020	0.968	0.817
t-test		(0.007)	(0.133)	(0.076)	(0.040)	(0.016)	(0.005)	(0.003)	(0.104)	(0.075)	(0.113)
Sunk	+	0.630	-0.070	0.294	0.292	0.313	0.553	0.446	-0.133	0.287	0.268
t-test		(0.019)	(0.925)	(0.403)	(0.150)	(0.077)	(0.006)	(0.009)	(0.823)	(0.527)	(0.588)
CapEx.	+	1.980	0.864	0.736	0.707	0.366	0.317	1.463	1.553	1.224	0.990
t-test		(0.008)	(0.336)	(0.139)	(0.018)	(0.230)	(0.470)	(<0.001)	(0.004)	(0.046)	(0.086)
Adj. R^2		0.981	0.944	0.974	0.987	0.988	0.986	0.990	0.955	0.962	0.967
F-test		(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Obs.		107	107	107	107	107	107	107	107	107	107

All variables are in USD per share. All Resources variables are multiplied by the USD spot price. Market value of equity (MVE) is the stock price six months after the financial year end. Reserves (Resv.) represent the economically-viable portion of Resources. Contingent (Con.) represents the economically-unviable portion of Resources. Inferred represents the untestable portion of Resources. Mineralised Material is Contingent plus Inferred. Developed Resources are Reserves plus Contingent. Bypr is commodities other than gold (total resources). BVE is the book value of ordinary equity minus Sunk and CapEx. Sunk is the book value of property, plant and equipment, and intangible assets. CapEx is the expected future expenditure on Sunk (from the feasibility report). GoldMove is the percentage lagged change in the spot price of gold (USD). Pos (Neg) Gold is the piece-wise positive (negative) decomposition of GoldMove. Regressions include adjustments for cross-sectional fixed effects. t-tests utilise White's diagonal corrected errors. p-values are two-tailed.

$$MVE_{i,t} = \beta_0 + \beta_1 PosGold_{i,t-T} + \beta_2 NegGold_{i,t-T} + \beta_3 SResv_{i,t} + \beta_4 PosGold_{i,t-T} * SResv_{i,t} + \beta_5 NegGold_{i,t-T} * SResv_{i,t} + \beta_6 SCon_{i,t} + \beta_7 PosGold_{i,t-T} * SCon_{i,t} + \beta_8 NegGold_{i,t-T} * SCon_{i,t} + \beta_9 SBypr_{i,t} + \beta_{10} BVEa_{i,t} + \beta_{11} Sunk_{i,t} + \beta_{12} CapEx_{i,t} + \varepsilon_{i,t}$$

Table 22F: Market value and current total resources decomposed into reserves and contingent resources: including interactions with lagged change in gold price - decomposed into positive and negative changes - t = 2001-2008.

	Pred.	T=1	T=2	T=3	T=4	T=5	T=6	T=7	T=8	T=9	T=10
Intercept		-0.157	-1.428	-1.038	0.873	0.423	0.441	-0.025	0.421	0.830	0.096
t-test		(0.858)	(0.360)	(0.428)	(0.360)	(0.730)	(0.784)	(0.987)	(0.772)	(0.537)	(0.944)
PosGold		-0.539	5.299	1.537	0.905	0.912	0.816	0.822	0.756	0.694	0.695
t-test		(0.693)	(0.012)	(0.142)	(0.211)	(0.116)	(0.116)	(0.055)	(0.067)	(0.082)	(0.051)
NegGold		9.692	-31.854	-4.915	-0.008	-0.915	-1.139	-1.157	-1.430	-1.102	-0.504
t-test		(0.232)	(0.059)	(0.633)	(0.997)	(0.586)	(0.592)	(0.628)	(0.560)	(0.748)	(0.827)
SResv.	+	0.137	0.093	-0.059	-0.215	-0.152	-0.012	0.034	0.143	0.081	0.274
t-test		(0.038)	(0.494)	(0.518)	(0.082)	(0.178)	(0.925)	(0.729)	(0.143)	(0.351)	(0.003)
*PosGold*SResv.*	0	0.547	0.456	0.417	0.488	0.317	0.205	0.144	0.118	0.138	0.056
t-test		(0.017)	(0.091)	(0.001)	(<0.001)	(0.001)	(0.029)	(0.024)	(0.025)	(0.014)	(0.134)
*NegGold*SResv.*	+	1.584	-7.599	0.737	-0.220	0.105	0.091	0.306	0.093	0.374	0.249
t-test		(0.111)	(0.244)	(0.339)	(0.547)	(0.674)	(0.772)	(0.391)	(0.825)	(0.483)	(0.586)
SCon.	0	-0.047	0.378	0.227	0.467	0.311	0.271	0.212	0.272	0.242	0.199
t-test		(0.499)	(0.080)	(0.067)	(0.001)	(0.007)	(0.022)	(0.137)	(0.047)	(0.133)	(0.048)
*PosGold*SCon.*	+	-0.488	-1.288	-0.637	-0.711	-0.442	-0.335	-0.264	-0.267	-0.270	-0.211
t-test		(0.288)	(0.040)	(0.011)	(<0.001)	(<0.001)	(0.003)	(0.010)	(0.003)	(0.007)	(0.002)
*NegGold*SCon.*	0	-1.051	12.418	0.979	0.576	0.213	0.118	-0.036	0.292	0.241	0.006
t-test		(0.644)	(0.084)	(0.480)	(0.276)	(0.558)	(0.846)	(0.964)	(0.751)	(0.843)	(0.992)
SBypr.	+	-0.109	-0.091	-0.109	-0.103	-0.115	-0.115	-0.099	-0.089	-0.094	-0.079
t-test		(<0.001)	(0.054)	(<0.001)	(0.001)	(0.001)	(0.018)	(0.009)	(0.033)	(0.012)	(0.055)

Table 22F: Market value and current total resources decomposed into reserves and contingent resources: including interactions with lagged change in gold price - decomposed into positive and negative changes - t = 2001-2008 (cont.).

	Pred.	T=1	T=2	T=3	T=4	T=5	T=6	T=7	T=8	T=9	T=10
BVE	+	1.387	1.582	1.088	1.453	1.711	1.689	1.724	1.644	1.662	1.396
t-test		(0.174)	(0.039)	(0.178)	(0.031)	(0.018)	(0.022)	(0.029)	(0.038)	(0.032)	(0.077)
Sunk	+	1.886	1.372	1.599	0.801	1.206	1.027	1.108	0.648	0.675	0.832
t-test		(<0.001)	(0.003)	(<0.001)	(0.006)	(0.002)	(0.030)	(0.017)	(0.167)	(0.147)	(0.072)
CapEx.	+	1.562	0.993	2.537	2.052	2.606	1.853	2.372	0.952	1.590	-0.056
t-test		(0.261)	(0.521)	(0.111)	(0.206)	(0.135)	(0.303)	(0.221)	(0.579)	(0.434)	(0.970)
Adj. R^2		0.929	0.901	0.931	0.933	0.931	0.916	0.919	0.911	0.919	0.906
F-test		(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Obs.		214	214	214	214	214	214	214	214	214	214

All variables are in USD per share. All Resources variables are multiplied by the USD spot price. Market value of equity (MVE) is the stock price six months after the financial year end. Reserves (Resv.) represent the economically-viable portion of Resources. Contingent (Con.) represents the economically-unviable portion of Resources. Inferred represents the untestable portion of Resources. Mineralised Material is Contingent plus Inferred. Developed Resources are Reserves plus Contingent. Bypr is commodities other than gold (total resources). BVE is the book value of ordinary equity minus Sunk and CapEx. Sunk is the book value of property, plant and equipment, and intangible assets. CapEx is the expected future expenditure on Sunk (from the feasibility report). GoldMove is the percentage lagged change in the spot price of gold (USD). Pos (Neg) Gold is the piece-wise positive (negative) decomposition of GoldMove. Regressions include adjustments for cross-sectional fixed effects. t-tests utilise White's diagonal corrected errors. p-values are two-tailed.

$$MVE_{i,t} = \beta_0 + \beta_1 PosGold_{i,t-T} + \beta_2 NegGold_{i,t-T} + \beta_3 SResv_{i,t} + \beta_4 PosGold_{i,t-T} * SResv_{i,t} + \beta_5 NegGold_{i,t-T} * SResv_{i,t} + \beta_6 SCon_{i,t} + \beta_7 PosGold_{i,t-T} * SCon_{i,t} + \beta_8 NegGold_{i,t-T} * SCon_{i,t} + \beta_9 SBypr_{i,t} + \beta_{10} BVEa_{i,t} + \beta_{11} Sunk_{i,t} + \beta_{12} CapEx_{i,t} + \varepsilon_{i,t}$$

Table 22G: Market value and decomposed current total resources: including interactions with exploration expenditure and the proportion of reserves to developed resources – separated by period sub-samples.

	Pred.	Panel i 1995-2000	Panel ii 2001-2008
Intercept		3.375	5.220
t-test		(0.002)	(0.005)
Expl.		-5.231	-14.566
t-test		(0.109)	(0.051)
Resv./Dev.		-1.456	-7.261
t-test		(0.196)	(0.017)
SResv.	+	0.242	0.418
t-test		(0.040)	(<0.001)
*Expl.*SResv.*	?	2.013	5.484
t-test		(0.469)	(0.768)
Con.	+	-0.359	-0.327
t-test		(0.133)	(0.029)
*Expl.*SCon.*	+	-2.403	10.197
t-test		(0.273)	(0.222)
Inf.	0	0.004	0.169
t-test		(0.970)	(0.389)
*Expl.*SInf.*	+	3.979	-12.025
t-test		(0.016)	(0.295)
*SInf.*Resv./Dev.*	?	-0.194	-0.328
t-test		(0.457)	(0.302)
*Expl.*SInf.*Resv./Dev.*	+	-2.213	19.216
t-test		(0.286)	(0.255)

Table 22G: Market value and decomposed current total resources: including interactions with exploration expenditure and the proportion of reserves to developed resources – separated by period sub-samples (cont.).

		Panel i	Panel ii
	Pred.	1995-2000	2001-2008
SBypr.	+	-0.202	-0.086
t-test		(0.001)	(0.077)
BVE	+	0.730	1.509
t-test		(0.435)	(0.062)
Sunk	+	-0.046	1.169
t-test		(0.957)	(0.009)
CapEx.	+	-1.273	0.127
t-test		(0.212)	(0.937)
Adj. R^2		0.970	0.900
F-test		(<0.001)	(<0.001)
Obs.		107	214

All variables are in USD per share. All Resources variables are multiplied by the USD spot price. Market value of equity (MVE) is the stock price six months after the financial year end. Reserves (Resv.) represent the economically-viable portion of Resources. Contingent (Con.) represents the economically-unviable portion of Resources. Inferred (Inf.) represents the untestable portion of Resources. Mineralised Material is Contingent plus Inferred. Developed Resources (Dev.) are Reserves plus Contingent. Bypr is commodities other than gold (total resources). BVE is the book value of ordinary equity minus Sunk and CapEx. Sunk is the book value of property, plant and equipment, and intangible assets. CapEx is the expected future expenditure on Sunk (from the feasibility report). Expl. is the current expenditure on exploration (USD, deflated by Current Reserves). Regressions include adjustments for cross-sectional and period fixed effects. t-tests utilise White's diagonal corrected errors. p-values are two-tailed.

$$MVE_{i,t} = \beta_0 + \beta_1 Expl_{i,t} + \beta_2\, Resv_{i,t}/Dev_{i,t} + \beta_3 SResv_{i,t} + \beta_4 Expl_{i,t} * SResv_{i,t} + \beta_5 SCon_{i,t} + \beta_6 Expl_{i,t} * SCon_{i,t} + \beta_7 SInf_{i,t} + \beta_8 SInf_{i,t} + \beta_9 SInf_{i,t} * Resv_{i,t}/Dev_{i,t} + \beta_{10} Expl_{i,t} * SInf_{i,t} * Resv_{i,t}/Dev_{i,t} + \beta_{11} SBypr_{i,t} + \beta_{12} BVEa_{i,t} + \beta_{13} Sunk_{i,t} + \beta_{14} CapEx_{i,t} + \varepsilon_{i,t}$$

Table 23A: Market value (3 months after financial year end) and decomposed current total resources: including interactions with exploration expenditure and the proportion of reserves to developed resources.

	Pred.	Panel i JORC & NI 43-101	Panel ii JORC & NI 43-101	Panel iii JORC & NI 43-101
Intercept		8.219	9.076	36.791
t-test		(0.053)	(0.058)	(0.051)
Expl.			-30.208	-71.264
t-test			(0.185)	(0.088)
Resv./Dev.				-38.848
t-test				(0.065)
SResv.	+	0.122	0.208	0.439
t-test		(0.602)	(0.354)	(0.016)
*Expl.*SResv.*	?		-25.326	0.880
t-test			(0.169)	(0.948)
Con.	+	-1.122	-1.206	-1.629
t-test		(0.129)	(0.125)	(0.080)
*Expl.*SCon.*	+		26.369	14.560
t-test			(0.121)	(0.286)
Inf.	0	-0.937	-0.988	-1.904
t-test		(0.138)	(0.140)	(0.303)
*Expl.*SInf.*	+		4.374	-1.856
t-test			(0.260)	(0.875)
*SInf.*Resv./Dev.*	?			1.431
t-test				(0.465)
*Expl.*SInf.*Resv./Dev.*	+			13.301
t-test				(0.437)

Table 23A: Market value (3 months after financial year end) and decomposed current total resources: including interactions with exploration expenditure and the proportion of reserves to developed resources (cont.).

		Panel i	Panel ii	Panel iii
	Pred.	JORC & NI 43-101	JORC & NI 43-101	JORC & NI 43-101
SBypr.	+	0.132	0.120	0.149
t-test		(0.473)	(0.499)	(0.399)
BVE	+	3.411	3.287	2.214
t-test		(0.123)	(0.133)	(0.211)
Sunk	+	4.508	4.406	3.615
t-test		(0.080)	(0.083)	(0.077)
CapEx.	+	3.476	2.895	-1.928
t-test		(0.417)	(0.480)	(0.614)
Adj. R2		0.667	0.664	0.690
F-test		(<0.001)	(<0.001)	(<0.001)
Obs.		321	321	321

All variables are in USD per share. All Resources variables are multiplied by the USD spot price. Market value of equity (MVE) is the stock price three months after the financial year end. Reserves (Resv.) represent the economically-viable portion of Resources. Contingent (Con.) represents the economically-unviable portion of Resources. Inferred (Inf.) represents the untestable portion of Resources. Mineralised Material is Contingent plus Inferred. Developed Resources (Dev.) are Reserves plus Contingent. Bypr is commodities other than gold (total resources). BVE is the book value of ordinary equity minus Sunk and CapEx. Sunk is the book value of property, plant and equipment, and intangible assets. CapEx is the expected future expenditure on Sunk (from the feasibility report). Expl. is the current expenditure on exploration (USD, deflated by Current Reserves). Regressions include adjustments for cross-sectional and period fixed effects. t-tests utilise White's diagonal corrected errors. p-values are two-tailed.

Panel i: $MVE_{i,t} = \beta_0 + \beta_1 SResv_{i,t} + \beta_2 SCon_{i,t} + \beta_3 SInf_{i,t} + \beta_4 SBypr_{i,t} + \beta_5 BVEa_{i,t} + \beta_6 Sunk_{i,t} + \beta_7 CapEx_{i,t} + \varepsilon_{i,t}$

Panel ii: $MVE_{i,t} = \beta_0 + \beta_1 Expl_{i,t} + \beta_2 SResv_{i,t} + \beta_3 Expl_{i,t} * SResv_{i,t} + \beta_4 SCon_{i,t} + \beta_5 Expl_{i,t} * SCon_{i,t} + \beta_6 SInf_{i,t} + \beta_7 Expl_{i,t} * SInf_{i,t} + \beta_8 SBypr_{i,t} + \beta_9 BVEa_{i,t} + \beta_{10} Sunk_{i,t} + \beta_{11} CapEx_{i,t} + \varepsilon_{i,t}$

Panel iii: $MVE_{i,t} = \beta_0 + \beta_1 Expl_{i,t} + \beta_2 Resv_{i,t}/Dev_{i,t} + \beta_3 SResv_{i,t} + \beta_4 Expl_{i,t} * SResv_{i,t} + \beta_5 SCon_{i,t} + \beta_6 Expl_{i,t} * SCon_{i,t} + \beta_7 SInf_{i,t} + \beta_8 SInf_{i,t} + \beta_9 SInf_{i,t} * Resv_{i,t}/Dev_{i,t} + \beta_{10} Expl_{i,t} * SInf_{i,t} * Resv_{i,t}/Dev_{i,t} + \beta_{11} SBypr_{i,t} + \beta_{12} BVEa_{i,t} + \beta_{13} Sunk_{i,t} + \beta_{14} CapEx_{i,t} + \varepsilon_{i,t}$

Table 23B: Market value (3 months after financial year end) and current total resources decomposed into reserves and contingent resources: including interactions with lagged change in gold price - decomposed into positive and negative changes.

	Pred.	T=1	T=2	T=3	T=4	T=5	T=6	T=7	T=8	T=9	T=10
Intercept		9.619	7.014	7.280	6.454	8.490	8.896	11.231	11.860	11.737	10.740
t-test		(0.048)	(0.037)	(0.041)	(0.039)	(0.019)	(0.011)	(0.008)	(0.005)	(0.004)	(0.004)
PosGold		-9.522	17.870	11.285	12.694	8.859	8.036	6.704	6.653	7.067	8.047
t-test		(0.403)	(0.170)	(0.150)	(0.057)	(0.112)	(0.076)	(0.083)	(0.040)	(0.049)	(0.038)
NegGold		17.430	-3.018	-5.943	-9.679	-5.312	-3.036	4.179	4.870	8.595	-1.526
t-test		(0.318)	(0.797)	(0.527)	(0.185)	(0.448)	(0.639)	(0.510)	(0.413)	(0.231)	(0.735)
SResv.	+	0.362	-0.367	-0.552	-1.116	-0.755	-0.880	-0.751	-0.794	-0.668	-0.681
t-test		(0.081)	(0.493)	(0.298)	(0.071)	(0.150)	(0.061)	(0.075)	(0.044)	(0.067)	(0.064)
*PosGold*SResv.*	0	-1.332	1.059	0.784	1.648	0.841	0.945	0.756	0.834	0.833	0.921
t-test		(0.118)	(0.182)	(0.136)	(0.018)	(0.038)	(0.013)	(0.019)	(0.007)	(0.009)	(0.006)
*NegGold*SResv.*	+	0.855	1.848	2.082	0.416	1.627	1.223	1.813	1.572	1.604	0.450
t-test		(0.711)	(0.288)	(0.207)	(0.588)	(0.126)	(0.144)	(0.075)	(0.255)	(0.149)	(0.498)
SCon.	0	-1.643	-1.158	-1.166	0.505	-0.378	0.077	-0.141	0.190	0.071	0.332
t-test		(0.109)	(0.199)	(0.223)	(0.179)	(0.493)	(0.807)	(0.735)	(0.580)	(0.827)	(0.233)
*PosGold*SCon.*	+	4.841	-0.970	-0.977	-2.728	-1.411	-1.495	-1.219	-1.293	-1.346	-1.578
t-test		(0.127)	(0.593)	(0.412)	(0.030)	(0.116)	(0.037)	(0.042)	(0.009)	(0.012)	(0.006)
*NegGold*SCon.*	0	-1.671	-5.798	-3.917	1.636	-1.536	-0.384	-1.979	-0.277	-0.141	1.854
t-test		(0.857)	(0.360)	(0.361)	(0.227)	(0.431)	(0.756)	(0.347)	(0.886)	(0.937)	(0.215)
SBypr.	+	-1.120	-0.501	-0.451	0.211	-0.299	-0.070	-0.228	-0.070	-0.212	-0.148
t-test		(0.108)	(0.201)	(0.287)	(0.345)	(0.328)	(0.725)	(0.325)	(0.823)	(0.434)	(0.526)

Table 23B: Market value (3 months after financial year end) and current total resources decomposed into reserves and contingent resources: including interactions with lagged change in gold price - decomposed into positive and negative changes (cont.).

	Pred.	T=1	T=2	T=3	T=4	T=5	T=6	T=7	T=8	T=9	T=10
BVE	+	1.824	-1.014	-0.637	-1.779	-0.814	-0.971	-0.716	-0.855	-0.816	-0.873
t-test		(0.206)	(0.281)	(0.256)	(0.055)	(0.146)	(0.074)	(0.094)	(0.046)	(0.060)	(0.051)
Sunk	+	1.510	1.779	2.516	1.441	1.267	0.852	0.127	0.128	-0.945	0.472
t-test		(0.654)	(0.390)	(0.193)	(0.110)	(0.134)	(0.284)	(0.901)	(0.939)	(0.476)	(0.584)
CapEx.	+	0.096	0.102	0.175	0.074	0.132	0.040	0.083	0.010	0.029	0.083
t-test		(0.545)	(0.628)	(0.427)	(0.676)	(0.539)	(0.829)	(0.625)	(0.936)	(0.821)	(0.481)
Adj. R^2		0.700	0.683	0.696	0.762	0.721	0.757	0.762	0.800	0.791	0.802
F-test		(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Obs.		321	321	321	321	321	321	321	321	321	321

All variables are in USD per share. All Resources variables are multiplied by the USD spot price. Market value of equity (MVE) is the stock price six months after the financial year end. Reserves (Resv.) represent the economically-viable portion of Resources. Contingent (Con.) represents the economically-unviable portion of Resources. Inferred represents the untestable portion of Resources. Mineralised Material is Contingent plus Inferred. Developed Resources are Reserves plus Contingent. Bypr is commodities other than gold (total resources). BVE is the book value of ordinary equity minus Sunk and CapEx. Sunk is the book value of property, plant and equipment, and intangible assets. CapEx is the expected future expenditure on Sunk (from the feasibility report). GoldMove is the percentage lagged change in the spot price of gold (USD). Pos (Neg) Gold is the piece-wise positive (negative) decomposition of GoldMove. Regressions include adjustments for cross-sectional fixed effects. t-tests utilise White's diagonal corrected errors. p-values are two-tailed.

$$MVE_{i,t} = \beta_0 + \beta_1 PosGold_{i,t-T} + \beta_2 NegGold_{i,t-T} + \beta_3 SResv_{i,t} + \beta_4 PosGold_{i,t-T} * SResv_{i,t} + \beta_5 NegGold_{i,t-T} * SResv_{i,t} + \beta_6 SCon_{i,t} + \beta_7 PosGold_{i,t-T} * SCon_{i,t} + \beta_8 NegGold_{i,t-T} * SCon_{i,t} + \beta_9 SBypr_{i,t} + \beta_{10} BVEa_{i,t} + \beta_{11} Sunk_{i,t} + \beta_{12} CapEx_{i,t} + \varepsilon_{i,t}$$

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Appendix: Glossary of technical terms from the extractive industries

Area of interest: the accounting treatment for exploration costs in Australia. "An individual geological area which is considered to constitute a favourable environment for the presence of a mineral deposit or an oil or natural gas field, or has been proved to contain such a deposit or field." (AASB 6, §Aus7.3)

By-product: "A secondary metal or mineral product recovered in the milling process such as copper and silver." (Barrick Gold Corporation 2008 Annual Report, page 77). Also known as 'production credits.'

Cash costs: "Total cash costs include all costs absorbed into inventory, as well as royalties, **by-product** credits, and production taxes, and exclude inventory purchase accounting adjustments, unrealized gains/ losses from non-hedge currency and commodity contracts, and amortization and accretion." (Barrick Gold Corporation 2008 Annual Report, page 77)

CIM: Canadian Institute of Mining, Metallurgy and Petroleum, the Canadian professional mining body responsible for the **CIM Definition Standards**.

CIM Definition Standards: The Canadian **resource reporting code** first issued by the **CIM** in 2000 (effective February 2001) and enshrined into Canadian securities law through **NI 43-101**.

CSA: Canadian Securities Administrators, the group of provincial Canadian securities regulators responsible for the old **NPS 2-A** and the current **NI 43-101**.

Commercial viability: "When a project is commercial, this implies that the essential social, environmental and economic conditions are met, including political, legal, regulatory and contractual conditions. In addition, a project is commercial if the degree of commitment is such that the accumulation is expected to be developed and placed on production within a reasonable time frame." (**PRMS**, page 31) See also '**modifying factors**.'

Competent person: the person responsible for making an estimate of **mineral resources** or **ore reserves**. The necessary qualifications are outlined in the relevant **resource reporting code**. Also known as 'qualified person.'

Contained mineral: "Represents [units of mineral] in the ground before reduction [due to] not [being] able to be **recovered** by the applicable metallurgical process." (Barrick Gold Corporation 2008 Annual Report, page 77) Contained mineral = **tonnage * grade**.

Contingent resources: "Those quantities of [minerals] estimated, as of a given date, to be potentially recoverable from known accumulations by application of development projects but which are not currently considered to be **commercially recoverable** due to one or more contingencies. Contingent Resources are a class of [**mineral**] **resources**." (**PRMS**, page 32) Comprises contingent **measured resources** and contingent **indicated resources**.

Core drilling: "drilling with a hollow bit with a diamond cutting rim to produce a cylindrical core that is used for geological study and assays. Used in mineral exploration." (Barrick Gold Corporation 2008 Annual Report, page 77) See also '**in-fill drilling**.'

Cut-off grade: "the minimum metal grade at which an orebody can be economically mined (used in the calculation of ore reserves [and mineral resources])." (Barrick Gold Corporation 2008 Annual Report, page 77). When estimating **ore reserves** or **mineral resources**, the cut-off grade is the minimum grade entered into the estimate, with lower grades being entered as zero. See also '**top-cut grade**.'

Definition: the estimation of **ore reserves** within **mineral resources**, including **dilution**.

Developed resources: **Mineral resources** that have been explored to a reasonable or high level of **geological confidence**. Comprises **ore reserves** and **contingent resources**. Not to be confused with 'developed reserves,' as used in the oil and gas industry. Note that the term 'developed resources' is not used in the extractive industries, and is used only for the purposes of my thesis.

Development: "Work carried out for the purpose of opening up a mineral deposit." (Barrick Gold Corporation 2008 Annual Report, page 77)

Dilution: "The effect of waste or low-grade ore which is unavoidably included in the mined ore, lowering the **recovered grade**." (Barrick Gold Corporation 2008 Annual Report, page 77)

Drilling: Includes **core drilling** and **in-fill drilling**.

Evaluation: the estimation of **mineral resources**; including estimating tonnage, grade and contained mineral.

Exploration: searching for **mineral resources** and **ore reserves**, including **prospecting**, **evaluation** and **definition**.

Extraction: digging up ore from the ground. Also known as 'mining.' Note that these terms can also refer to the broader operating activities of the extraction/mining industry

Feasibility report: a report outlining the **commercial viability** (**definition**) of **ore reserves**. Includes (in increasing order of detail) back-of-envelope feasibility reports, pre-feasibility reports, preliminary feasibility reports and final feasibility reports.

Full cost method: an accounting treatment for exploration costs in North America. "All costs associated with property acquisition, exploration, and development activities … shall be capitalized … [and subsequently] amortized on the unit-of-production basis using proved oil and gas reserves." (**SEC** Regulation S-X §210.4-10,17,c) See also '**successful efforts method**.'

Geological confidence: the level of confidence attributed to an estimate of **mineral resources**, based on the number and spacing of drill hole data relative to the type of geological formation involved. Includes (in increasing order of confidence) low, reasonable and high (**inferred**, **indicated**/**probable** and **measured**/**proven resources**/**reserves** respectively).

Grade: "The amount of metal in each ton of **ore**, expressed as troy ounces per ton or grams per tonne for precious metals and as a percentage for most other metals." (Barrick Gold Corporation 2008 Annual Report, page 77) See also '**cut-off grade**,' '**mill-head grade**,' '**recovered grade**,' and '**reserve/resource grade**.'

Indicated resources: "that part of a **Mineral Resource** for which tonnage, densities, shape, physical characteristics, **grade** and **mineral content** can be estimated with a reasonable level of **confidence**. … The locations are too widely or inappropriately spaced to confirm geological and/or **grade** continuity but are spaced closely enough for continuity to be assumed. … **Confidence** in the estimate is sufficient to allow the application of technical and economic parameters, and to enable an evaluation of economic viability." (**JORC Code** §21)

Inferred resources: "that part of a **Mineral Resource** for which tonnage, **grade** and **mineral content** can be estimated with a low level of **confidence**. It is inferred from geological evidence and assumed but not verified geological and/or grade continuity. … **Confidence** in the estimate of Inferred Mineral Resources is usually not sufficient to allow the results of the application of technical and economic parameters to be used for detailed planning. For this reason, there is no direct link from an Inferred Resource to any category of **Ore Reserves** (see Figure [2]).” (**JORC Code** §20)

In-fill drilling: “any method of drilling intervals between existing holes, used to provide greater geological detail and to help establish **reserve estimates**.” (Barrick Gold Corporation 2008 Annual Report, page 77) See also ‘**core drilling**.’

In situ: Latin for ‘in position.’ Refers to **mineral resources** that are still in the ground, as opposed to **ROM stockpile**.

JORC: Joint Ore Reserves Committee, the group of Australasian professional and industry mining bodies, responsible for the **JORC Code**.

JORC Code: The Australasian **resource reporting code** first issued by the **JORC** in 1989 and enshrined into Australian securities law through the ASX Listing Rules, and the Corporations Act.

Marginal resources: **Contingent resources** which are close to being reclassified as **ore reserves**.

Measured resources: “that part of a **Mineral Resource** for which tonnage, densities, shape, physical characteristics, **grade** and **mineral content** can be estimated with a high level of **confidence**. … The locations are spaced closely enough to confirm geological and **grade** continuity. … the nature, quality, amount and distribution of data are such as to leave no reasonable doubt, in the opinion of the **Competent Person** determining the **Mineral Resource**, that the **tonnage** and **grade** of the mineralisation can be estimated to within close limits, and that any variation from the estimate would be unlikely to significantly affect potential economic viability. … **Confidence** in the estimate is sufficient to allow the application of technical and economic parameters and to enable an evaluation of economic viability that has a greater degree of certainty than an evaluation based on an **Indicated Mineral Resource**." (**JORC Code** §22)

Mill-head grade: "metal content of mined ore going into a mill for processing." (Barrick Gold Corporation 2008 Annual Report, page 77)

Milling: "A process… where ore is finely ground and thereafter undergoes physical or chemical treatment to extract the valuable metals." (Barrick Gold Corporation 2008 Annual Report, page 77)

Mineralised material: **contingent resources** and **inferred resources**, *i.e.* **mineral resources** that are not **ore reserves**. Also known as '**resources** excluding **reserves**.' Note that while the term 'mineralised material' is not mentioned in SEC Industry Guide 7, it is nonetheless applied by **SEC** registrants as SEC Industry Guide 7 prohibits the use of the term '**resources**' to describe **resources** excluding **reserves**.

Mineral resources: "a concentration or occurrence of material of intrinsic economic interest in or on the Earth's crust in such form, quality and quantity that there are reasonable prospects for eventual economic extraction." (**JORC Code** §19) Comprises **ore reserves**, **contingent resources** and **inferred resources**.

Modifying factors: "mining, metallurgical, economic, marketing, legal, environmental, social and governmental considerations" when estimating **ore reserves**. (**JORC Code** §28) See also '**commercial viability**.'

NI 43-101: the national instrument from the **CSA** that enshrines the **CIM Definition Standards** into Canadian law in 2000 (effective 2001). NI 43-101 includes additional requirements beyond the **Definition Standards**, such as **technical reports**.

NPS 2-A: the national policy statement from the **CSA** comprising the **resource reporting code** enshrined into Canadian law prior to **NI 43-101**.

Ore: "Rock, generally containing metallic or non-metallic minerals, which can be mined and processed at a profit." (Barrick Gold Corporation 2008 Annual Report, page 77)

Ore reserves: "the economically mineable part [subject to **modifying factors**] of a **Measured** and/or **Indicated Mineral Resource**." (**JORC Code** §28) Also known as 'mineral reserves.' Comprises **proven reserves** and **probable reserves**.

PRMS: the Petroleum Resources Management System, the **resources reporting code** for oil and gas resources.

Possible reserves: the **commercially viable** part of **inferred resources**. Possible reserves are permitted under the **PRMS** and the **NPS 2-A**, but not the **JORC Code**, the **SME Guide**, SEC Industry Guide 7, the **CIM Definition Standards**, or the **NI 43-101**.

Probable reserves: "the economically mineable part of an **Indicated**, and in some circumstances, a **Measured Mineral Resource**." (**JORC Code** §29)

Processing: Includes **milling** and **refining**.

Production: Includes **extraction** and **processing**.

Prospecting: the first phase in the search for **mineral resources**. Includes **drilling**.

Proven reserves: "the economically mineable part of a Measured Mineral Resource." (**JORC Code** §30) Also known as 'proved reserves.'

Recovered grade: "actual metal content of ore determined after processing." (Barrick Gold Corporation 2008 Annual Report, page 77)

Recovery rate: "A term used in process metallurgy to indicate the proportion of valuable material physically recovered in the **processing** of **ore**. It is generally stated as a percentage of the material recovered compared to the total material originally present." (Barrick Gold Corporation 2008 Annual Report, page 77)

Refining: "The final stage of metal production in which impurities are removed from the molten metal." (Barrick Gold Corporation 2008 Annual Report, page 77)

Rehabilitation: "The process by which lands disturbed as a result of mining activity are modified to support beneficial land use." (Barrick Gold Corporation 2008 Annual Report, page 77) Also known as 'reclamation.'

Reserve/resource grade: "estimated **metal content** of an orebody, based on **reserve**[/**resource**] calculations." (Barrick Gold Corporation 2008 Annual Report, page 77) **Contained mineral** = **tonnage** * **grade**.

Resource reporting code: the rules and principles under which resource estimates are made and reported in a particular jurisdiction. Issued, overseen and enforced by the relevant professional mining body and/or securities regulator. Includes the **CIM Definition Standards** / **NI 43-101**, the **JORC Code**, the **PRMS**, SEC Industry Guide 7, and the **SME Guide**.

ROM stockpile: the run-of-mine stockpile of ore in between extraction and processing.

SEC: the Securities and Exchange Commission, the USA securities regulator responsible for SEC Industry Guide 7.

SEC Industry Guide 7: the legally binding USA **resource reporting code** first issued by the **SEC** in 1981, supplanting the **SME Guide**.

SME: Society for Mining, Metallurgy and Exploration, the USA professional mining body responsible for the **SME Guide**.

SME Guide: the **resource reporting code** first issued by the **SME** in 1991, supplanted by the legally binding **SEC Industry Guide 7**.

Successful efforts method: an accounting treatment for exploration costs in North America. "The costs of **drilling exploratory** [activities] … shall be capitalized … pending determination of whether the well has found … **reserves**. If the well has found … **reserves**, the capitalized costs of **drilling** the well shall become part of the enterprise's wells and related equipment and facilities (even though the well may not be completed as a **producing** well); if, however, the well has not found … **reserves**, the capitalized costs of **drilling** the well, net of any salvage value, shall be charged to expense." (SFAS 19 §19) See also '**full costs method**.'

Technical report: a thoroughly extensive report, required by NI 43-101, to accompany the disclosure of a new **mineral resource** estimate within 45 days of filing a document based on that estimate. Prepared in accordance with Form 43-101F1.

Tonnage: the volume of ore (expressed in metric tonnes or imperial tons) of an orebody in which the mineral contained is estimated. **Contained mineral** = tonnage * **grade**.

Top-cut grade: When estimating **ore reserves** or **mineral resources**, the top-cut grade is the maximum grade entered into the estimate, with higher grades being entered as the top-cut grade. See also '**cut-off grade**.'