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GAS RESERVES AND EQUITY VALUATION: IMPLICATIONS FOR ACCOUNTING STANDARDS

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Abstract
The coal seam gas industry is an important and rapidly developing sector of the Australian mining industry. This sector provides an excellent site to test the relevance of the Hotelling Valuation Principle (HVP) in explaining the market capitalisation of this industry sector. Currently, the majority of listed firms in this sector do not have positive cash flows from the sale of gas. The HVP posits that market values are a function of company reserves. We test five measures of firm reserves as explanations of market capitalisation. After controlling for scale differences, we find that 2P Reserves have the highest explanatory power. No other measure of reserves or resources plays any significant role in explaining market capitalisation.

Keywords: Gas reserves. Equity valuation. Accounting standards.

Introduction

The nature and importance of mining projects to the world economy generally warrants the use of suitable and accurate valuation models. The types of activities undertaken by mining firms make their valuation different from the valuation of more conventional types of investment activities. In particular, a world shift in energy needs has seen an increasing focus on the development of liquid natural gas (LNG) as an alternate energy source. The popularity of LNG as an alternate energy source to oil is based on its capacity to reduce greenhouse gas emissions.

A significant portion of the Australian natural gas market centres on the production of coal seam gas. This form of gas production involves dewatering the underground coal deposits and producing low pressure methane gas flows. While some companies have

achieved gas sales to the local electricity generation market a significant number of participants in the coal seam gas industry are yet to make any significant cash flows. This poses a problem for the valuation of this form of Resource Company. In this paper we assess the relevance of the Hotelling Valuation Principle in explaining the market capitalization of coal seam gas resource companies. In doing so, we also identify the type of information needed for resource companies to fully inform the investing public.

Theory of resource valuations

The Hotelling Valuation Principle is based on the traditional discount cash flow models adapted for the special conditions of the resource sector. At the heart of this method is the need to specify the total reserves of the company. Determining which form of reserves drives market value is the focus of this research.

Historically the present value of expected future cash flows has been estimated using some variate of the discounted cash flow (DCF) analysis[1]. DCF is most commonly used for valuing the Australian mining sector (Bartrop and White, 1995, Torries, 1998) and the global mining industry in general (Brennan and Schwartz, 1985a). DCF techniques involve discounting all the expected-future cash flows from a project at the risk-adjusted required rate of return to obtain the project's present value (PV). In this approach, the adjustment for risk is made to the discount rate.

The general specification for the DCF method can be expressed as:

$$V_{Fit} = \sum_{t=1}^{T} \frac{\overline{F_t}}{(1+\overline{r})^t}$$

(1)

where:

$V_{Fit} =$ present value of firm i at the end of period t;

$\overline{F_t} =$ the period t, expected net cash flow after corporate tax, i.e., the mean of the distribution of possible F_t; (it includes any salvage value);

$t =$ project life

$\overline{r} =$ the expected opportunity cost of capital, defined as the equilibrium expected rate of return on equivalent risk securities after corporate tax.

Equation (1) captures the present value of the firm's cash flows to give total firm value to all contributors of capital. The cost of capital of a levered firm ($\overline{r}$) is taken to be the

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[1] Discounted cash flow techniques form the mainstay of investment decision evaluation in modern finance texts, refer BREALEY, R. A. & MYERS, S. C. (2000) *Principles of Corporate Finance,* Boston, Irwin McGraw-Hill, COPELAND, T. E. & WESTON, J. F. (1988) *Financial Theory and Corporate Policy*, Addison-Wesley, BISHOP, S. R., CRAPP, H. R., FAFF, R. W. & TWITE, G. J. (1993) *Corporate Finance,* Sydney, Holt, Rinehart and Winston., and PEIRSON, G., BROWN, R., EASTON, S. & HOWARD, P. (1998) *Business Finance,* Sydney, McGraw Hill Australia.

marginal cost of debt as measured by the after tax weighted-average cost of capital (WACC) (Modigliani and Miller, 1958).

The popularity of the DCF approach derives from its sound theoretical foundations (Fisher, 1965). The application of this model has attracted considerable criticism because it is believed that it often understates the value of a project, and hence firm value (Hayes and Abernathy, 1980, Hayes and Garvin, 1982, Trigeorgis, 1995, Myers, 1987 #163, Davis, 1996). Researchers argue that conventional DCF methods do not conform to the complexities of the mining process (Trigeorgis, 1995, Paddock et al., 1988). It is not the model per se, but the common application and misuse of the model that often results in projects and the firm being undervalued (Myers, 1987, Hodder and Riggs, 1985). The theoretical elegance of the DCF model belies the difficulties in the practical estimation of its parameters.

The criticisms directed at the application of the DCF technique can be categorised into:

1)   The inherent difficulties of forecasting expected future cash flows (Paddock et al., 1988).
2)   The sensitivity of the value to the discount rate;
3)   The static approach of the DCF to the input parameters.

These criticisms are not easily overcome in markets with high levels of uncertainty (Cortazar and Schwartz, 1993 p.517), as is the case in most mining ventures.

Empirical Evidence on DCF Valuations

Prior research has had difficulties reconciling observed market values of mining firms with the present value of expected cash flows using DCF methods (Kester, 1984, Paddock et al., 1988, Miller and Upton, 1985b, Davis, 1996). Kester (1984) believes that all of the difference between DCF values and market values is attributable to the exclusive and strategic operating and investment options managers hold.

Recent empirical testing of the accuracy of DCF models has emerged in the accounting literature. This research is driven from the desire to substantiate the value relevance of accounting numbers and in so doing provides some empirical evidence as to the performance of DCF models for equity valuation (Penman and Sougiannis, 1998, Kaplan, 1986). Table 1 summaries the empirical research into DCF equity valuation.

In addition to the research in Table 1, Davis (1996) found the adjusted market capitalization value of ten major US and Canadian gold firms mining assets to be 30% below the estimated present value of these assets using DCF analysis. This infers one must increase DCF values by an average of 43% to obtain the market value of the assets owned by these firms.

Similarly Paddock, Siegel and Smith (1988) report that the winning bid for undeveloped mineral properties is often greater than the ex ante expected DCF value. In a survey of 21 Federal Outer Continental Shelf (OCS) oil tract leases, Paddock et al (1988) found the winning bid was an average of 184% higher than the tract's estimated DCF value as calculated by the United States Geological Survey. The mean bid for each tract was,

over the 21 tracts, an average of 23% above the estimated DCF value. Part of this phenomenon has been attributed to the nature of the bidding process (the "winner's curse"), but many of the losing bids and the average bid values are still greater than the DCF valuation.

For a sample of 92 observations Miller and Upton (1985b) found a correlation coefficient of 0.628 between DCF values and market prices for "proved" oil reserves. Paddock Siegel and Smith (1988) find a poorer correlation coefficient between DCF value and the winning bid in offshore oil tract leases of 0.18.

Table 1: Summary of Empirical Research into Discounted Cash Flow Equity Valuation

Author	Sample	Equity Valuation Models	Performance Metrics	Findings
Francis, Olsson & Oswald (2000)	3000 firm-yr observations 1989-1993 Examines analysts forecasts for individual securities. Ex-ante value estimates	Div -Discounted Dividends FCF-Discounted Free Cash Flow AE Abnormal Earnings	Precision metric - Median absolute prediction error. |(Est-Mv)l/Mv univariate & multivariate regression.	Div valuations explained 51% of MV compared to 35% for FCF and 71% for AE.
Penman & Sougiannis (1998)	An average of 4,192 firms per year for 18 years randomly assigned to 20 portfolios.	DDM - Discounted Dividends DCFM - Discounted Cash Flow RIM - Residual Income Model CM - Capitalization Method	Error Metric- (observed portfolio price- Estimated Intrinsic value)/observed portfolio price.	DCF valuation errors +VE > 150% of actual price. Accrual earnings & book values have lower valuation errors than dividends or cash flows.
Kaplan & Ruback (1995)	51 Highly Levered transactions 1983-1989.	DCF- Discounted Cash Flow Comparable coy multiples	Errors metric- log of the ratio of estimated value/transaction value.	Valuations of DCF forecasts are within 10%, on average of market values.
Paddock, Siegel & Smith (1988)	21 oil tracts with 92 observations.	DCF - Discounted Cash Flow Real Options	Correlation Coefficients	Correlation between DCF and wining industry bids = 0.18.
Berkman, Bradbury & Ferguson (1999)	45 firms listing on New Zealand stock exchange between 1989 and 1995.	DCF –Discounted Cash Flow P/E Multiples - Price/Earnings.	Error metric - median absolute pricing error (Est-Mv)/Mv. Explanatory power tested via OLS regression.	Median absolute pricing error of 30.8% for DCF values and 38.3% for P/E model. DCF explains 51% of cross-sectional variation in MV scaled by BV.
Miller & Upton (1985a)	92 sample observations from 39 oil & gas firms between 1979 and 1981.	DCF – Herold Appraisals at 10% discount rate. SEC – mandated values at 10% discount rate.	Correlation Coefficients	Herold DCF values explain 62.8% of MV compared to 54.7% for SEC values.

The evidence suggests the DCF values as generally applied do not fully explain market values. This is particularly important in the Australian mining sector where research suggests that mining firms are trading at significant premiums to the DCF value (Adamson, 1999, Torries, 1998). Adamson (1999) finds this phenomenon across a number of continents North America, South Africa and Australia. The size of the premium is related to a firm's ability to generate additional reserves and resources, which equates to improved growth in future earnings.

Hotelling's Valuation Principle

The DCF method requires a number of unobservable parameters to be estimated, for example, expected future cash flows and the appropriate cost of capital, making its practical implementation problematic. Evidence from prior studies indicates DCF methods undervalue relative to market prices.

A special case of DCF analysis is the HVP model (Miller and Upton, 1985b) specifically developed for the valuation of mineral assets. The present value of a mining firm's assets that are currently operating and optimally managed using the Hotelling Valuation Principle "depends mainly on current period prices and extraction costs, *regardless of when the reserves are extracted*" (emphasis added) (Miller and Upton, 1985b, p.3).

HVP assumes the objective of the firm is to maximize the present value of profits from extracting a known and finite quantity of ore. It derives the present value of in-ground resources from the theory of optimal mineral exploitation, which is used to forecast future mineral prices and the appropriate risk-adjusted discount rate. The principle relies on Hotelling's (1931) theory of the price path of commodities known as the "R" percentage rule. This rule determines that the expected trend of future net revenues and the appropriate discount rate are linked.

The Hotelling (1931) proposition is that the unit price of an exhaustible natural resource, net of extraction costs, should grow at a rate equal to the rate of interest (i.e., the rate of discount). Optimal production requires that the extraction rate of a mine to be chosen such that the discounted marginal net profit of extracting ore today should be constant in all periods (Watkins, 1992). This implies the irrelevancy of the interest rate and future commodity prices.

Assuming asset value maximization, if commodity prices follow such a price path the theory implies that the present value of net commodity prices would be the same whenever the resource is extracted. The present value of reserves that are left in the ground until some future point in time to take advantage of a higher price will be discounted at the rate of interest that cancels out the effect of the price increase. If net price exhaustible resource commodities rise at the rate of discount, than each unit of reserve has a present value equal to its current net price.

The logic of the rule is that maximisation of present value profits ensures that they cannot be increased by reallocating output. This could only hold if marginal present value

profits were constant over all periods. Consequently, marginal profits must rise at the discount rate (Watkins, 1992). In other words, an unconstrained, profit-maximising, price-taking owner of an exhaustible resource will choose to produce so that net price rises at the rate of interest r%. The rule is always interpreted as price net of extraction costs. Thus the market price to users could fall or stay constant while the net price rose, if extraction costs fell. This assumes that the producer is a price taker in a competitive resource industry.

The HVP provides a testable model of the value of a resource such as coal seam gas, because it avoids two of the major criticisms of traditional DCF. It eliminates the need to forecast future cash flows and avoids the problem of determining the appropriate discount rate because growth in future commodity prices equals the discount rate.

Hotelling (1931) article, titled "The Economics of Exhaustible Resources", is identified as the seminal article in this area and has received renewed attention with the surge in interest in natural resource valuations. The origin of the paper is attributed to Gray (1914) that proposes that mine owners arrange extraction so that the present value of price less extraction cost is constant through time. Hotelling extended Gray (1914) at the industry level. Hotelling's analysis has two objectives: to assess the policy debates arising out of the conservation movement, which he addresses by analysing the rate of optimal natural resource depletion of irreplaceable assets and; to develop a theory of the equilibrium price path of natural resources[2].

Miller and Upton (1985a) extended Hotelling's "R" percentage principle to allow its application to the value of the resource firm rather than just the determination of the resource price. The HVP formulation allows its application to firm valuation. Oil and gas resource economics analysing the relationship between commodity prices and resource stocks is dominated by the HVP (Watkins, 1992). Solow (1974) sees the HVP as a basis for the economics of exhaustible resources. It has been widely adopted by industry analysts, US National Income accountants and the Bureau of Economic Analysis in their effort to value national oil reserve stocks (Davis and Moore, 1998) as well as natural gas export policy assessments in Canada (Watkins, 1992). Nabar (1997) also uses the HVP model for gold mining valuation, while Harris and Ohlson (1987) use the HVP model for valuing oil and gas properties.

Empirical Evidence on Hotelling Valuation Principle

There is both direct and indirect evidence on the performance of the HVP as a valuation method. The indirect tests provide evidence on the validity of the original Hotelling (1931) "R" percentage rule. The direct tests examine the ability of the model to describe asset market prices.

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[2] Refer to DEVARAJAN, S. & FISHER, A. C. (1981) Hotelling's "Economics of Exhaustible Resources": Fifty Years Later. *Journal of Economic Literature,* 19**,** 65-73.or a review of the implications of Hotelling's principle on natural resource economics.

Most attempts to empirically validate Hotelling's "R" percentage rule examine the relationship between interest rate levels and growth rates of net commodity prices. These studies assume that if markets for exhaustible resources are efficient, then there will be a strong association between the rates of change of resource prices and the rate of return on other assets. However, the majority of these time-series studies do not provide support for Hotelling's principle (Heal and Barrow, 1980, Smith, 1981).

Heal and Barrow (1980) test a model where market interest rates reflect the alternative earnings that could be earned by a commodity trader. Using a time-series model of lags of interest rates and income, they reject the hypothesis that the level of the interest rates is a significant explanatory factor in their model of net mineral commodity prices. Smith (1981) results are consistent with those of Heal and Barrow for a sample covering twelve minerals over the period 1900 to 1973. Farrow (1985) empirical results reject the basic Hotelling hypothesis as a good descriptor of the firm's behaviour.

Agbeyegbe (1989) tests a Hotelling model that allows for agents' expectations in their decisions to hold on to or dispose of various assets. They conclude that it is changes in the rate of interest rather than the level of interest rates that are important in determining the rate of capital gain from an exhaustible resource.

Pindyck (1978) extends the Hotelling model to take account of the interactive effects of exploration and production on mineral prices. Under competitive and monopoly environments he examines the optimal rates of exploration and production of a resource to describe its entire price and reserve profile. Using oil data over the period 1965-74 Pindyck finds that mineral's prices increase as prescribed by Hotelling during the later stage of a limited resource's extraction. However, when initial reserves of a resource are small, the price profile is U-shaped, rather than steadily increasing as predicted in Hotelling's model. Pindyck's extension provides useful insights into the general pricing process of minerals.

The evidence of the various testable hypothesis of Hotelling's (1931) "R" percentage rule from the oil and gas industry is mixed. Miller and Upton (1985b) question whether these results are decisive on the basis that these prior empirical works contain a number of serious deficiencies resulting from measurement errors particularly in the extraction cost component of net prices (Miller and Upton, 1985b)p.2).

The HVP specification lends itself to empirical testing by regressing observed market values per unit of reserve against net market prices. The implication of the principle for this regression is $\alpha = 0$ and a slope coefficient $\beta = 1$. A number of papers suggest that the HVP substantially overestimates the market value of reserves, with regressions for unit reserve value, V/R, on net price, revealing a slope coefficient of around 0.5 (Adelman and Watkins, 1995, Miller and Upton, 1985b, Watkins, 1992). Watkins (1992) finds that the HVP overestimates the market value of 27 Canadian oil and gas reserves by an average of 85%. In contrast Adelman and Watkins (1995) find a strong relationship between Hotelling valuations and market prices for 34 developed oil and gas reserves in

Alberta over the period 1989 to 1991 with 88% explanatory power, but implied prices from the model are still below the net wellhead prices.

Miller and Upton (1985b) test the HVP model values at several points in time during 1979-81 for a sample of US domestic oil- and gas-producing firms. They test alternative specifications of the HVP model under three different sets of assumptions. In its simplest form the model assumes constant returns to scale in current as well as cumulative extraction. This assumption implies additional variables such as interest rates or projected future mineral prices contribute nothing to the explanatory power of the model.

The second specification allows for non-constant returns to scale in current production. The third extension allows for extraction costs to be a function of cumulative production. Intuitively the lowest cost units will tend to be produced first, leaving higher cost units until last. Allowing extraction costs to rise with cumulative production implies net prices will rise slower than the real rate r (Miller and Upton, 1985b p.8).

Miller and Upton's (1985b) tests involve pooled, cross-sectional regressions of the relationship between observed market values and the values implied by the HVP model. Hotelling values account for approximately 41% of the variation in market values. The explanatory power of the HVP is robust over a variety of alternative specifications of the variables and equations. However, the HVP is found to systematically overestimate the market value of oil and gas reserves in 92% of the 192 valuations performed. Miller & Upton conclude that the HVP measure is a better indicator of the market value for petroleum properties than two widely-cited publicly available measures of reserve value (SEC-mandated valuations and Herold publications' "Oil Industry Comparative Appraisals"). More recent evidence from Crain and Jamal (1991) in relation to the petroleum industry is supportive of the descriptive ability of HVP. They find the HVP model values explain 73.2% of observed market prices.

The limited empirical evidence on the HVP model suggests it may overvalue natural resource commodities, particularly oil and gas reserves with the exception of Adelman and Watkins (1995). Davis and Moore (1998) suggests that a better valuation rule might be adjusted to reduce the values by a constant 50%. McDonald (1994), argues this occurs because of the strong assumption of a constant fixed quantity of reserves that does not allow for increased reserves over time due to acquisition or discovery, and that these assumptions do not hold in the regulated oil and gas industry. Producers cannot respond to price signals in a profit maximizing manner by adjusting output, and thus the basic tenets of the valuation principle fall down (McDonald, 1994, Watkins, 1992).

Aivazian and Callen (1979) suggest the success of the valuation principle is "a function not only of the industry structure in the output market and the nature of the extraction technology but also of the industry structure governing the extraction of the resource" (p. 85). The application of the HVP may be more relevant to valuing gold producers than oil and gas participants as the gold industry is more competitive with no one producer or country dominating supply. In addition, there is far less regulation over production and the industry in general. In the case of US and Canadian gold mining firms, which are not

regulated, White (1996) finds that HVP values proved and probable gold reserves at an average of 8% below the average market value.

Hotelling Valuation Model Implications for Coal Seam Gas Reserves.

The HVP method is attractive in its simplicity and avoids the difficulty of forming expected future cash flows and the appropriate cost of capital. The essence of the models is that reserves, market prices and cost of extraction are the only variables needed to form a valuation of a coal seam gas project. The current state of the Australian coal seam gas industry is such that no clear market prices exist, the cost of extraction is available for a few companies only and approximately 80% of producers have no cash flows estimable for the at least five years. A number of liquid natural gas plants (up to five) are planned for construction in the port town of Gladstone. There are twenty explorers with various classed of reserves.

In this paper we test whether there is any relationship between one of the main variables in the HVP model, reserves and the market capitalisation of the industry participants. The second issue of interest is which class of reserves has the greatest explanatory power. Figure 1 shows the Resource Classification System (Etherington, 2007) as defined by Society of Petroleum Engineers and partners[3].

The system defines the major resources classes: Production, Reserves, Contingent Resources and Prospective Resources as well as Unrecoverable petroleum. Reserves are defined as those quantities of petroleum which are anticipated to be commercially recovered from known accumulations from a given date forward. Contingent Resources are those quantities of petroleum which are estimated, on a given date, to be potentially recoverable from known accumulations, but which are not currently considered to be commercially recoverable.   Contingent Resources may include, for example, accumulations for which there is currently no viable market, or where commercial recovery is dependent on the development of new technology, or where evaluation of the accumulation is still at an early stage. Undiscovered Petroleum-initially-in-place is that quantity of petroleum which is estimated, on a given date, to be contained in accumulations yet to be discovered. The estimated potentially recoverable portion of Undiscovered Petroleum-initially-in-place is classified as Prospective Resources.

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[3] The approving partners consist of the Society for Petroleum Engineers. The International Accounting Standards Board, the Society o Exploration Geophysicists, the Society of Petroleum Evaluation Engineers, US Energy Information Agency, and the World Petroleum Council.
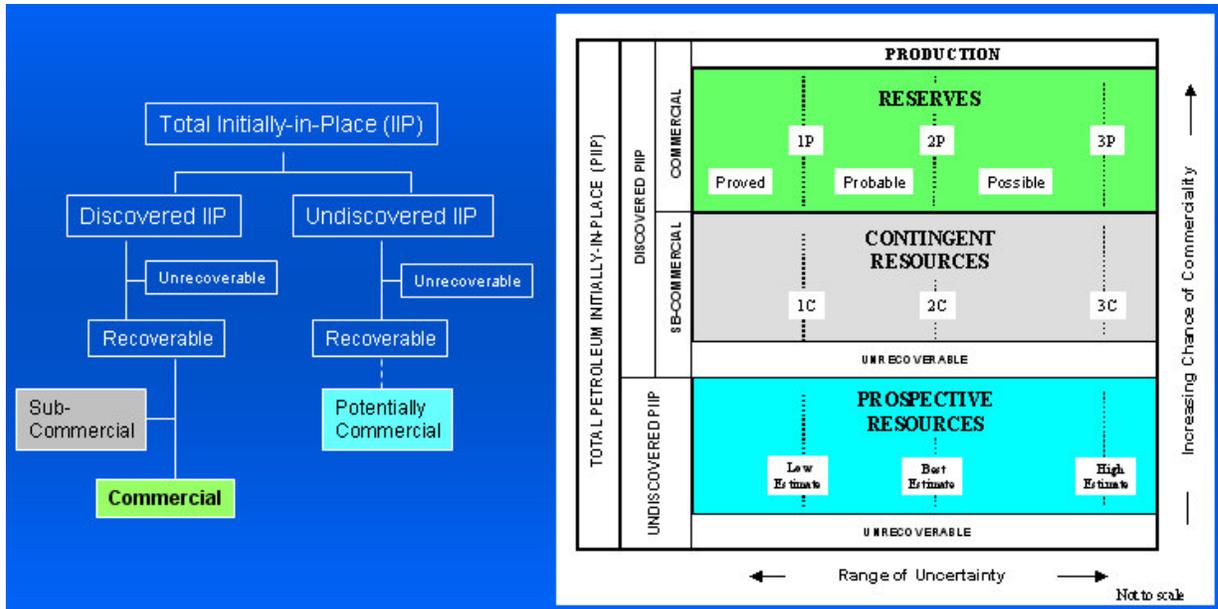
Figure 1: Resources classification system.

The Range of Uncertainty, as shown in Figure 1, reflects a reasonable range of estimated potentially recoverable volumes for a field. Any estimation of resource quantities is subject to both technical and commercial uncertainties. In the case of reserves, and where appropriate, this range of uncertainty can be reflected in estimates for Proved Reserves (1P), Proved plus Probable Reserves (2P) and Proved plus Probable plus Possible Reserves (3P) scenarios. For other resource categories, the terms Low Estimate, Best Estimate and High Estimate is used.

The major hypothesis of this research is that all classification of resources contribute to the market's assessment of the valuation of a firms gas resources.

Research Design

The primary hypothesis for this research was tested on the 28 members of the Coal Seam Gas (GSG) companies listed on the Australian Stock Exchange (ASX). Four separate models were used to test the hypothesis. In the first model, five published measures of CSG resources were regressed against the total market capitalization of the participants. These measures were 2P Reserves, 3P Reserves, Combined 2C and 3C Resources, and Gas Initially In Place (GIIP). GIIP is the measurement published for prospective resources – those undiscovered resources with no proven commercial potential. While we would expect the GIIP measures not to have explanatory power, they do form the precursor to future resources with higher degrees of commerciality and certainty.

Model 2 tests the hypothesis that 2P Reserves alone drives the market capitalization. Give the nature of the reserves certification process, we would expect 2P and 3P reserves to be highly correlated in the GSG industry One difficulty in the CSG industry is the existence of two large companies. These companies may distort the reserves market

capitalization relationship. To control for this possible scale effect, models 4 and five tested the explanatory power of P2 Reserves with natural log transformations and with natural log transformations with two outliers excluded.

Sample

The sample consisted of all companies listed in the CSG sector of the ASX resource stocks. Table 2 shows the sample companies and their various resources.

Company	ASX Code	Last Price 8-Sep-08	Total Issue shares (Mill)	Mkt Cap (A$M)	2P Reserves PJ	3P Reserves PJ	2C/3C Resources PJ	2P Target Reserves PJ	GIIP PJ
Arrow Energy	AOE	3.18	701	2,229	1,430	3,127	-	2,000	36,225
Molopo Australia	MPO	1.25	183	229	316	643	373	2,381	47,610
Qld Gas Company	QGC	4.8	821	3,941	2,415	7,163	-	-	19,665
Sunshine Gas	SHG	3	310	931	469	1,097	-	-	-
Sydney Gas	SGL	0.34	403	137	41	54	-	238	65,205
QGC & SHG QGC1 -	QGC1	-	4,094	2,884	-	-	19,665	38	2.46
AJ Lucas - CSG* AJL*	AJL*	6.46	65	243	164	385	205	-	3,105
Blue Energy BUL	BUL	0.27	445	120	-	-	-		22,046
Bow Energy BOW	BOW	0.27	151	41	-	-	-	-	200
Comet Ridge COI	COI	0.18	105	19	-	-	-	-	-
Eastern Corp. ECU	ECU	0.32	72	23	-	-	-	-	13,869
Eastern Star Gas ESG	ESG	0.59	703	415	128	845	-	-	17,595
Eden Energy EDE	EDE	0.2	180	36	-	-	-	-	-
European Gas EPG	EPG	0.6	199	119	140	380	-	-	1,450
Icon Energy ICN	ICN	0.25	298	73	-	-	-	-	5,630
Metgasco MEL	MEL	0.8	132	106	264	1,419	-	640	41
Planet Gas PGS	PGS	0.08	202	16	-	-	-	-	-
Pure Energy PES	PES	1.87	73	136	-	-	2,055	300	51,750
Rawson Res. RAW	RAW	0.1	72	7	-				-
Redfork Energy RFE	RFE	0.47	89	42	28				-
Sapex SXP	SXP	0.7	68	47	-				20,700
VicPet VPE	VPE	0.23	320	74	-				518
Westside WCL	WCL	0.56	61	34	-				259
Santos STO	STO	18.75	595	11,163	4,486				63,135
AGL AGK	AGK	14.53	443	6,442	318	921	24,850		-
Origin ORG	ORG	17.65	881	15,552	5,770				-
Woodside WPL	WPL	58.21	688	40,068	6,457				-
TOTAL CSG			26,172	43,352	369,002	306	1.21	3.6	2.94
Average			458	3153	1602	1603	9430	933	20500
Standard Deviation			771	8263	2281	2131	11875	1001	22722

The data was collected by a leading broking firm based on information contained in the 30 June reports of mining companies. Market capitalization was measured at 8 Sptember 2008.

Analysis

Model 1

The first model estimated is based on the whole sample of 28 companies and tests the association between all the various reserve measures and market capitalisation by estimating the following regression:

$$MktCap = \quad + \quad _1P2 + \quad _2P3 + \quad _3C23 + \quad _4Tar2P + \quad _5GIIP$$

Table 3 presents the results and shows that the only significant explanatory variable is P2 reserves and GIIP has marginal explanatory power at the 10% level. Hence we tested the explanatory power of P2 as the only explanatory variable but only included those 16 firms that had P2 reserves. This was done on the basis that something else drives value for the other companies.

Model 2

This model proposes that P2 reserves alone drive cross sectional variation in market capitalisation.

$$MktCap = \quad + \quad _1P2$$

The results for model 2 are shown in Panel A of Table 43

A plot of the data for the 16 companies revealed that market capitalisation and P2 reserves were both non linear cross-sectional. To correct for this the first 2 models were re-estimated this time taking natural log transformation of both the dependant and independent variables – these models are labelled Model 3 and 4. Again P2 is the only significant driver of market capitalisation. However the mean absolute percentage error (i.e. actual market capitalisation vs. predicated by the regression model) are much lower for the transformed data. Hence the transformation produced a better fit to the data and less forecast error. This is important where the model is to be used for valuation purposes.

On further examination of the absolute errors it was apparent that there were extreme outliers for 2 of the 16 companies with P2 reserves. Hence these two companies were excluded and the analysis rerun (Model 5) the mean errors are halved. Significantly in this last model there is almost a one for one relationship between the P2 reserves and market capitalisation cross sectionally.

Table 3 Relationship between Market Capitalisation and Reserves

	n		ι					Adj. R^2	Mean Forecast Error
Panel A: Raw Data									
All Firms	28	793.44	4.11	-0.39	-0.25	1.31	-0.08	0.7673	1403.5%
		0.79	9.48	-1.05	-1.57	0.87	-1.88		
			***				*		
P2 Only Firms	16	-790.02	3.78					0.6908	1440.6%
		-0.44	5.87						
			***						
Panel B: Transformed Data									
All Firms	28	3.79	0.67	-0.06	-0.05	0.03	-0.08	0.7754	109.0%
		9.60	8.67	-0.85	-0.57	0.33	-1.50		
		***	***						
P2 Only Firms	16	0.23	1.08					0.8137	99.4%
		0.27	8.15						
			***						
P2 Only - Excluding Extremes	14	0.25	1.04					0.8950	43.4%
		0.41	10.57						
			***						

Model 1: All Firms

Model 2: P2 Only Firms

Model 3: All Firms – Ln Transformed Data

Model 4: P2 Only Firms – Ln Transformed Data

Model 5: P2 Only Firms Excluding Extremes – Ln Transformed Data

*,**,or *** significantly different from zero at 10, 5, or 1% significance level

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