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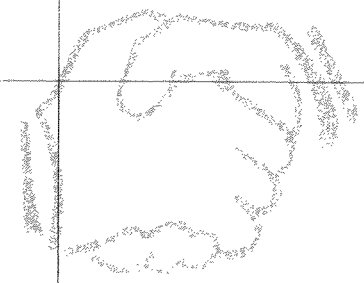

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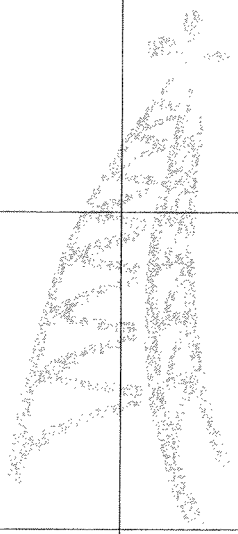

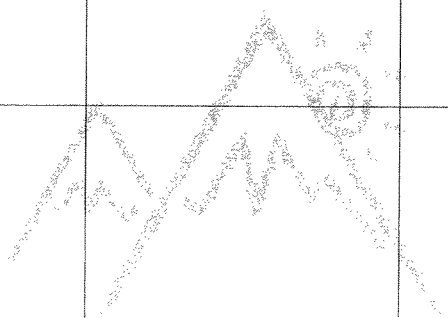

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Asset Impairment and Accounting Conservatism: Evidence from the Oil and Gas Industry

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Introduction

Proved oil and gas (O&G) reserves represent the primary operating assets of O&G producing firms. Based on the historical costs incurred in finding and developing O&G reserves, these assets are accounted for using either the full cost (FC) method or the successful efforts (SE) method. The two methods mainly differ in how they account for the drilling cost of exploratory wells. Under SE accounting, exploration costs associated with unsuccessful wells are expensed and exploration costs relating to commercially-viable wells are capitalized. Under FC accounting, exploration costs associated with both successful and unsuccessful wells are capitalized. Of the two methods, FC accounting produces on average the higher operating income and assets, allowing for the risk characteristics of the drilling program and the rate of growth in exploration expenditures. However, regardless of the accounting method used—or the degree of conservatism imbedded in accounting rules and estimates—movements in O&G prices (as well as revisions to reserve estimates and changes in development and production costs) may lead to significant changes in the level of accounting conservatism applied to O&G assets and may, under certain circumstances, result in aggressive accounting treatments by both FC and SE firms.

To eliminate the possibility of aggressive accounting associated with their O&G assets, O&G firms are required to apply asset-impairment rules that in effect function as a "lower of cost or market" test and represent an application of accounting conservatism. In 1978, the Securities and Exchange Commission (SEC) required FC firms to apply ceiling-test impairment rules specified in Regulation SX 4-10. The SEC encouraged, but did not formally require, SE firms to adopt these rules. In 1995, the Financial Accounting

Standards Board (FASB) required SE firms (and other non-O&G firms) to apply the asset-impairment rules specified in Statement of Accounting Standards (SFAS) No. 121[1] (superseded by SFAS 144).[2]

FC firms have continuously argued that Regulation SX 4-10 mandates unjustified levels of asset write-downs especially during periods of significant oil price declines. Their main concern relates to (1) the mandated use of quarter-end O&G prices and costs in estimating write-downs and (2) the requirement to apply the impairment test on a quarterly basis. Noting that SFAS 121 does not impose similar requirements, FC firms have frequently appealed to the SEC to amend or temporarily suspend Regulation SX 4-10, arguing that it leads to unwarranted conservative accounting at the end of write-down quarters. Invariably, the SEC has declined to amend or suspend regulation SX 4-10. However, on December 31, 2008, the SEC introduced a number of amendments to enhance investors' understanding of O&G reserves and the valuation of O&G firms (SEC Release 33-8995; 31 December 2008). These amendments include a revision to Regulation SX 4-10, which allows FC firms to use an average price based upon the prior 12-month period rather than period-end prices in the ceiling calculation. The new ruling will take effect on January 1, 2010, for annual reports on Forms 10-K and 20-F for fiscal years ending on or after December 31, 2009.

The aim of our study is to provide evidence on the impact of asset-impairment rules on accounting estimates for O&G assets by both FC and SE firms. Consistent with the extant literature, we begin our analysis by expressing share price as a function of both reported book value of equity and comprehensive earnings, the two primary summary financial-statement measures. Using the valuation framework discussed by Feltham and Ohlson (1996), we introduce accounting conservatism into the price model in three ways. First, we add current cash-investments to the price regression to control

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[1] While the aim of the impairment rules under SFAS 121 is to align the book and market values of O&G assets when events suggest that impairment has occurred, the SEC argues that the ceiling test calculations are not intended to portray a reflection of the fair value of O&G reserves (SEC Release 33-8995 31 December 2008).

[2] In October 2001, the FASB issued SFAS 144, "Accounting for the Impairment or Disposal of Long-Lived Assets" which superseded SFAS 121 but retained the latter's rules for long-lived assets held for use. It also established a single accounting model for long-lived assets to be disposed of.

for accounting conservatism associated with positive net present value (NPV) projects. Second, we add "as-reported" lagged operating non-O&G assets to control for accounting conservatism associated with accounting rules and estimates for non-O&G assets. Finally, we add "as-reported" lagged operating O&G assets (net O&G property, plant, and equipment) to capture accounting conservatism associated with accounting rules and estimates for O&G assets.

Using a sample of 2,243 quarterly observations that includes 54 SE firms and 51 FC firms during 1995-2004, we show that accounting by SE and FC firms is unbiased at the end of write-down quarters, suggesting that SFAS 121 and Regulation SX 4-10 do eliminate aggressive accounting treatments during those periods and align the market and book values of O&G assets. Our tests also show that accounting for O&G assets by FC and SE firms is conservative during zero write-down periods, consistent with the asymmetric nature of the impairment rules.

We then test the validity of the claims made by FC firms regarding the impact of Regulation SX 4-10 on accounting estimates for O&G assets during periods when O&G prices decline significantly. Consistent with the claims made by FC firms, we show that—when O&G prices decline significantly—accounting estimates for O&G assets by FC firms are conservative at the end of write-down periods, suggesting that write-down estimates during those periods are unjustifiably aggressive. In support of this evidence and consistent with Boone and Raman (2007), we find that FC firms recognize far more significant but fewer O&G asset write-downs relative to SE firms. During our sample period, FC firms recognized 91 O&G asset write-downs compared with 239 made by SE firms. However, the mean amount of individual write-downs by FC firms was more than four times that for SE firms. Our findings provide support to and are consistent with the evidence reported by Boone and Raman (2007) who observed lower association between security returns and write downs of FC firms relative to that of SE firms during 1995-2001. Our empirical results suggest the lower association observed by Boone and Raman (2007) could be mostly manifested during periods when O&G prices declined significantly.

Hypotheses Development

The Impact of Asset Impairment Rules on Accounting Conservatism

FC accounting method produces on average larger O&G operating-asset amounts than the SE approach, allowing for the risk characteristics of the drilling program and the rate of growth in exploration expenditures. To eliminate the possibility of aggressive accounting estimates for O&G assets, the SEC's Regulation SX 4-10 requires FC firms to perform quarterly stringent impairment-ceiling tests on total capitalized O&G costs. This test ensures that the capitalized costs for a cost center (defined as a country) do not exceed the cost-center ceiling. This ceiling is computed as the sum of: (1) the present value of future net revenue from proved reserves, discounted at a uniform rate of 10 percent and based on end-of-quarter O&G prices and costs; (2) the cost of properties not being amortized; (3) the lower of cost or market value of unproved properties being amortized; less (4) the tax effects associated with differences between the book and tax bases of properties. If a cost center's capitalized costs exceed its ceiling, an FC firm must recognize the difference as an asset write-down.

The application of the SE method may also lead to aggressive accounting estimates for O&G assets if, for example, O&G prices decline sufficiently. Prior to the issuance of SFAS No. 121: *Accounting for the Impairment of Long-Lived Assets and for Long-Lived Assets to Be Disposed Of* in 1995, there was no specific standard relating to write-downs of impaired long-lived assets for SE firms (or other non-O&G firms). However, SE firms are now required under SFAS No. 121 (superseded by SFAS 144) to test whether long-lived assets (such as the carrying amount of proved O&G reserves) have been impaired when events or changes in circumstances suggest that the relevant carrying amounts may not be recoverable.[3] Such events may include significant declines in O&G prices or significant increases in costs. SE firms must screen for impairments by comparing the carrying amounts of O&G assets with their *undiscounted* future net revenues. If the undiscounted future net revenues are less than carrying amounts, O&G assets are deemed to be impaired. The impairment loss is then computed as the excess of the asset's

[3] Gallun and Nichols (1995) pointed out that the FASB acknowledged informally that FC firms need not apply SFAS 121 for O&G properties However, it should be noted that FC firms should apply SFAS 121 to account for the potential impairment of their non-O&G assets.

carrying amount over its discounted future net revenues using *future* O&G prices and costs.

While a decline in O&G prices at balance sheet date is highly relevant for FC firms, they could be less relevant to SE firms since SFAS 121 permits reserves to be valued based on expected future O&G prices. In addition, a downward revision in estimated reserve quantities—arising independent of price decline—could trigger write-downs for both FC and SE firms. Also, exploration failures could trigger cost-driven impairments. This paper does not distinguish among these drivers of impairment since Regulation SX 4-10 and SFAS 121 aim to eliminate accounting aggressiveness associated with O&G assets regardless of the factors that led O&G firms to recognize asset impairment during a particular period. Therefore, on average, we expect to observe unbiased or conservative accounting estimates for O&G assets by FC and SE firms. That is, the market value of O&G assets will equal or exceed their carrying book value. This argument leads us to hypothesize that:

H1: On average, accounting estimates of O&G assets by O&G firms are unbiased or conservative.

The Impact of Asset Write-Downs on Accounting Conservatism

If O&G firms recognize sufficient write-downs when events suggest the presence of impairment, we expect to observe unbiased accounting at the end of quarters when write-downs occur. That is, the market value of O&G assets will be aligned with these assets' carrying book value at the end of write-down quarters. The presence of aggressive accounting for O&G assets during write-down quarters would suggest that O&G firms use write-downs opportunistically to minimize write-down amounts. Conversely, conservative accounting for O&G assets during write-down quarters would suggest that O&G firms use write-downs in a manner consistent with "big-bath" accounting.[4] The presence of conservative accounting estimates of O&G assets during write-down periods could also indicate that the impairment rules themselves force O&G firms to recognize unjustified levels of write-downs at

[4] For example, Boone and Coe (2001, Table 1) showed that SE firms would have substantially reduced their impairment losses had they applied the "option pricing model", which is allowed under SFAS 121, instead of the discounted cash flow technique when measuring the fair value of O&G assets.

certain periods. Note that the write-down rules of Regulation SX 4-10 and SFAS 121 are asymmetric in that they require write-downs but disallow subsequent write-ups. Therefore, we expect to observe conservative accounting estimates during periods of zero write-downs. That is, the market values of O&G assets will be higher than their carrying book values during those periods. These arguments lead us to hypothesize that:

H2: Accounting for O&G assets will be unbiased at the end of write-down quarters and conservative otherwise.

FC firms argue that Regulation SX 4-10 is generally more stringent than SFAS 121 for several reasons. First, the ceiling test must be performed every quarter as opposed to testing for impairment only when events warrant it under SFAS 121. As a result of this difference, a temporary O&G price decline may, at interim dates, force FC firms but not SE firms to recognize impairment write-downs. Second, while the ceiling test must be performed using discounted net revenues, SFAS 121 screens for impairment using undiscounted net revenues. Third, the ceiling test must be performed using end-of-quarter O&G prices whereas SFAS 121 is applied using future O&G prices. The use of discounted net revenues based on "depressed" end-of-quarter O&G prices—as opposed to undiscounted net revenues based on future prices—will produce lower cost-center ceilings which in turn could contribute to more frequent and/or larger ceiling-test write-downs. Fourth, in calculating future revenues, the ceiling test allows for the inclusion of net revenues relating to proved reserves only. Under SFAS 121, future net revenues may also include estimates relating to probable and possible reserves.[5] Excluding net revenues associated with probable and possible reserves from the calculation of future net revenues under the ceiling test will produce lower cost-center ceilings which, in turn, could also contribute to more frequent and/or larger ceiling-test write-downs.

In contrast, SFAS 121 is considered more stringent than Regulation SX 4-10 in one respect. SE firms are required to group their assets when applying SFAS 121 "at the lowest level [such as a field or reservoir level] for which there are identifiable cash flows that are largely independent of the cash flows of other groups of assets" (SFAS 121, paragraph 8). FC firms, on the other

[5] The terms *proved, probable,* and *possible reserves* are commonly identified in the industry as petroleum reserves that have a recoverability probability of at least 90%, 50%, and 10%, respectively.

hand, are allowed to group their assets at a country level. Grouping assets at field or reservoir level, as opposed to countrywide level, may result in fewer losses on some of the grouped assets being offset by gains on others. Consequently, the level of asset grouping required by SFAS 121 represents a more stringent requirement than that of the ceiling test, causing Gallun et al. (2001, p.244) to conclude that because of the level of asset grouping under SFAS 121,"the effect of the FC ceiling test may be much less dire than *SFAS No. 121*".

Despite the foregoing argument, FC firms continue to argue that Regulation SX 4-10 is far more stringent that SFAS 121 and causes unjustified levels of asset write-downs especially when oil prices decline sharply. Their main concern relates to the use of quarter-end O&G prices and costs and the requirement to apply the ceiling test on a quarterly basis.[6] If FC firms recognize unjustified levels of asset write-downs during periods when O&G prices decline significantly, we expect to observe conservative accounting treatments at the end of such periods. These arguments lead us to hypothesize:

H3a: Accounting for O&G assets by FC firms will be conservative at the end of write-down quarters during which O&G prices decline significantly.

H3b: Accounting for O&G assets by SE firms will be unbiased at the end of write-down quarters during which O&G prices decline significantly.

Empirical Model

Following the extant literature, we begin with a simple model which expresses security price (P) for firm i at the end of quarter t as a function of

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[6] For example, Alciatore et al (2000) state that the effects of temporary seasonal downswings of gas prices and the volatile nature of oil prices were highlighted during the oil price collapse of 1986 and further highlighted on March 27, 1991, when 26 full-cost companies and five of the Big Six accounting firms submitted an urgent petition to the SEC for a temporary waiver of the full-cost ceiling test. These companies requested that the SEC modify the full-cost ceiling to permit the use of a twelve-month moving average for both O&G prices.

book value of equity (BV) at the end of quarter t and comprehensive earnings (E) during quarter t:

$$P_{i,t} = \alpha_{i,t} + \beta_1 BV_{i,t} + \beta 2\ E_{i,t} + \epsilon_{i,t} \quad (1)$$

Equation (1) controls for time dummies to control for time dependencies but does not control for divergent levels of accounting conservatism by O&G producing firms. In the spirit of Feltham and Ohlson (1996) and Easton and Pae (2004), we introduce accounting conservatism into the price model in three ways as follows:

$$P_{i,t} = \alpha_{i,t} + \beta_1 BV_{i,t} + \beta 2\ E_{i,t} + \beta 3\ CI_{i,t} + \beta 4\ OG\_OA_{i,t-1} + \beta 5\ non\_OG\_OA_{i,t-1} + \epsilon_{i,t} \quad (2)$$

Where:

P	Market value of equity at balance sheet date;
BV	Book value of equity;
E	Comprehensive earning;
CI	Net cash investments in operating assets;
OG_OA	Net O&G property, plant, and equipment; and
Non-OG_OA	Non-O&G operating assets.

We add current cash investments (CI) to the price regression to control for accounting conservatism associated with positive NPV projects. This form of accounting conservatism arises because (1) investments in acquisition and exploration activities may take a considerable amount of time before a firm is able to assess the probability of success or failure in these activities and (2) the FC and SE accounting methods do not recognize success from positive NPV projects until discovered O&G reserves are developed and generate sales in subsequent quarters. Since conservative (aggressive) accounting understates (overstates) cash investments in operating assets, a positive (negative) coefficient on CI provides evidence consistent with conservative (aggressive) estimates of cash investments during the period. A positive coefficient on CI suggests that accounting estimates for positive NPV projects are conservative.

We add "as-reported" lagged operating non-O&G assets (non-O&G OA) to control for accounting conservatism associated with accounting rules and estimates for non-O&G assets. This form of accounting conservatism arises from the inherent conservatism in accounting rules and estimates associated with non-O&G assets. Since most financial assets are marked close to their market value, we expect this form of accounting conservatism to affect mostly operating non-O&G assets. This variable captures the cumulative effects of accounting conservatism associated with accounting rules and estimates for commencing non-O&G assets. Since conservative (aggressive) accounting understates (overstates) non-O&G operating assets, a positive (negative) coefficient on lagged non-O&G operating assets provides evidence consistent with conservative (aggressive) accounting estimates of non-O&G assets at the beginning of the period.

Finally, we add "as-reported" lagged operating O&G assets (O&G OA) to capture accounting conservatism associated with accounting rules and estimates for O&G assets. We use net *O&G property, plant, and equipment* to proxy for this form of accounting conservatism since this measure represents the net carrying value of O&G reserves. This form of accounting conservatism arises from the inherent conservatism in accounting rules and estimates associated with O&G assets and captures the cumulative effects of this phenomenon in relation to O&G assets at the beginning of a period. Since conservative (aggressive) accounting understates (overstates) operating O&G assets, a positive (negative) coefficient on lagged O&G operating assets provides evidence consistent with conservative (aggressive) accounting estimates of O&G assets at the beginning of a period.

Sample Selection and Data Description

The sample includes US O&G producing firms from the 1995-2004 sample period that are (1) classified as "domestic explorers and producers" in the *Herold* database, (2) have O&G operating revenues that exceed 50 percent

of total revenues,[7] and (3) have a positive pre write-down book value of equity. Consistent with prior studies, we exclude the top and bottom 1 percent of observations for each of our variables to mitigate the effect of extreme values.[8] We collected the required accounting and market data from the *Herold, Compustat*, and *CRSP* databases. We hand-collected write-down amounts (resulting from the application of SFAS 121 and the ceiling-test rules) from firms' 10-Q statements. The application of these criteria resulted in a sample of 2243 quarterly observations which included 54 SE firms and 51 FC firms.[9] We deflated all variables by beginning-of-year standardized measure (SD) of discounted net cash flows. This measure, required under SFAS 69, proxies for the fair market-value of O&G reserves.[10] Table 1 presents descriptive statistics for all 2,243 firm-quarterly observations and for each of the SE and FC sub-samples. The mean share price per SD is 0.75 and the mean book value per SD is 0.41. Interestingly, the mean and median values for these

[7] Prior studies have traditionally used a firm's Standard Industrial Classification (SIC) codes to proxy for the extent to which it is engaged in O&G exploration and production (SIC codes were replaced by the North American Industry Classification System in 1997). However, several concerns have been raised regarding the usefulness of the SIC codes (see for example, Kahle and Walkling [1996] and Clarke [1989]. We believe the use of operating revenue generated by O&G exploration and production activities is a more accurate proxy for a firm's level of exploration and production activities.

[8] The overall tenor of the results remains unchanged when we exclude observations: (1) with residuals that are two standard deviations from the means or (2) with Cook's distance equal to or greater than one.

[9] Although SFAS 121 was effective for fiscal years beyond 1995, the FASB permitted early implementation of the standard. Several firms in the sample early adopted SFAS 121 in 1995. The analyses in this study are repeated after deleting observations for the quarters in 1995. The tenor of the results remains unchanged.

[10] SFAS 69 requires all O&G firms to provide supplementary disclosures about the value of their O&G reserves using a standardized measure. We are aware of the potential impact of the scale effect on our empirical findings. We repeat our analyses using the following alternative scales to assess the potential impact of this problem: proved O&G reserve quantity, total assets, and sales revenues. We also repeat our analyses using weighted least-squares techniques. Overall, the tenor of our results remains unchanged. However, we believe that within the context of the O&G industry, our scale is quite suitable for the purpose of scaling the regression variables since all O&G firms must compute this measure using a uniform set of procedures.

statistics are quite similar for both FC and SE firms. The mean price-to-book ratio for the entire sample is 1.83 suggesting conservative accounting with respect to the combined effect of accounting rules and estimates as well as positive NPV activities. The mean price-to-book ratios for SE and FC firms are 1.85 and 1.76 respectively. The mean value for net cash investments in operating assets for the entire sample is 0.05 per SD. The equivalent ratios for FC and SE firms are 0.06 and 0.04 respectively, suggesting that FC firms are far more aggressive in their acquisition and exploration activities than SE firms.

Table 1
Descriptive Statistics of Research Variables
During the Sample Period 1995-20004

P is the market value of equity. BV is the book value of equity. E is comprehensive earnings. CI is net cash investments in operating assets. OG_OA is net capitalized O&G property, plants and equipments. Non-OG_OA is net non-O&G operating Assets. All variables are deflated by beginning of year standardized measure of the value of O&G reserves. (t denotes quarter and i denotes firm).

Variable	Mean	Median	Std, Dev.	1%	99%
Panel A: Total Observations (n = 2,243)					
$P_{i,t}$	0.75	0.75	0.27	0.18	1.41
$BV_{i,t}$	0.41	0.36	0.29	0.04	1.46
$E_{I,t}$	0.00	0.01	0.05	-0.22	0.06
$CI_{i,t}$	0.05	0.04	0.07	-0.14	0.30
$OG\_OA_{i,t-1}$	0.64	0.59	0.29	0.15	1.53
Non $OG\_OA_{i,t-1}$	0.06	0.02	0.12	0.00	0.49
Panel B: Successful Efforts Observations (n = 1,131)					
$P_{i,t}$	0.74	0.75	0.27	0.18	1.37
$BV_{i,t}$	0.40	0.35	0.26	0.06	1.25
$E_{I,t}$	0.00	0.00	0.05	-0.16	0.07
$CI_{i,t}$	0.04	0.03	0.07	-0.14	0.27
$OG\_OA_{i,t-1}$	0.63	0.57	0.28	0.15	1.52
Non $OG\_OA_{i,t-1}$	0.05	0.02	0.13	0.00	0.38

Table 1, continued

	Panel C: Full Cost Observations (n = 1,112)				
$P_{i,t}$	0.76	0.75	0.27	0.19	1.66
$BV_{i,t}$	0.43	0.37	0.31	0.03	1.68
$E_{i,t}$	0.00	0.01	0.05	-0.29	0.06
$CI_{i,t}$	0.06	0.04	0.07	-0.14	0.32
$OG\_OA_{i,t-1}$	0.64	0.62	0.29	0.14	1.56
Non $OG\_OA_{i,t-1}$	0.06	0.02	0.12	0.00	0.71

Table 2 presents descriptive statistics for all observations and for each of the SE and FC sub-samples during O&G write-down quarters. The total number of O&G write-downs during our sample period is 330 where the average value of O&G write downs stands at 6 percent of SD. The number of O&G write-downs reported by SE firms significantly exceeds those reported by FC firms. During our sample period, SE firms recognized 239 O&G asset write-downs, whilst FC firms recognized 91 write-downs (untabulated). The average number of SFAS 121 write-downs per SE firm is 4.42 and the average number of Regulation SX 4-10 write-downs per FC firm is 1.75. On the other hand, the average value of O&G write-downs by FC firms is 14 percent of SD compared with 3 percent by SE firms. As a percentage of pre-write down book value of equity, the average write-down by FC firms stands at 26 percent compared with 6.8 percent by SE firms. Interestingly, pre write-down earnings are positive for both FC and SE firms. Typically, firms recognize write-downs at times when they are performing poorly prior to write-down (Alciatore, et al 1998).

Table 2
Descriptive Statistics of Research Variables During the Write-Down Quarters

P is the market value of equity. BV is the book value of equity. E is comprehensive earnings. CI is net cash investments in operating assets. OG_OA is net capitalized OG property, plants and equipments. Non-OG_OA is net non-OG operating Assets. WD is O&G write-down. E* is pre write-down comprehensive earnings. B* is pre write-down book value of equity. All variables are deflated by beginning of year standardized measure of the value of O&G reserves. (t denotes quarter and i denotes firm).

Variable	Mean	Median	Std Dev.	1%	99%
Panel A: Total Observations (n = 330)					
$P_{i,t}$	0.74	0.74	0.27	0.19	1.25
$BV_{i,t}$	0.41	0.36	0.27	0.03	1.24
$E_{I,t}$	-0.05	-0.02	0.10	-0.44	0.09
$CI_{i,t}$	0.06	0.05	0.07	-0.15	0.30
$OG\_OA_{i,t-1}$	0.68	0.62	0.30	0.12	1.62
$Non\ OG\_OA_{i,t-1}$	0.05	0.02	0.13	0.00	0.61
$WD_{i,t}$	0.06	0.02	0.09	0.00	0.44
$E_{I,t}$ *	0.01	0.01	0.06	-0.20	0.16
$BV_{i,t}$*	0.47	0.41	0.31	0.08	1.38
Panel B: Successful Efforts Observations (n = 239)					
$P_{i,t}$	0.75	0.78	0.28	0.17	1.75
$BV_{i,t}$	0.41	0.36	0.29	0.05	1.90
$E_{I,t}$	-0.02	0.00	0.09	-0.48	0.11
$CI_{i,t}$	0.05	0.04	0.07	-0.17	0.38
$OG\_OA_{i,t-1}$	0.65	0.59	0.29	0.11	1.56
$Non\ OG\_OA_{i,t-1}$	0.05	0.02	0.14	0.00	0.84
$WD_{i,t}$	0.03	0.01	0.06	0.00	0.37
$E_{I,t}$ *	0.01	0.01	0.05	-0.25	0.14
$BV_{i,t}$*	0.44	0.38	0.31	0.09	2.08

Table 2, continued

Panel C: Full Cost Observations (n = 91)

$P_{i,t}$	0.69	0.69	0.23	0.21	1.27
$BV_{i,t}$	0.40	0.35	0.23	0.02	1.11
$E_{I,t}$	-0.12	-0.09	0.11	-0.46	0.02
$CI_{i,t}$	0.08	0.05	0.07	-0.04	0.31
$OG\_OA_{i,t-1}$	0.76	0.71	0.33	0.25	1.70
Non $OG\_OA_{i,t-1}$	0.05	0.02	0.11	0.00	0.67
$WD_{i,t}$	0.14	0.12	0.12	0.00	0.46
$E_{I,t}$ *	0.02	0.02	0.08	-0.22	0.48
$BV_{i,t}$*	0.54	0.49	0.28	0.04	1.42

Consistent with prior O&G studies, these statistics clearly show that Regulation SX 4-10 O&G asset write-downs impacted more severely on the pre write-down book value of equity and comprehensive earnings than comparable SFAS 121 write-downs.[11] Further, we observe that 85 percent of the reported O&G asset write-downs by FC firms are recognized during periods of O&G price declines compared with 54 percent by SE firms. While these statistics show that Regulation SX 4-10 does not force FC firms to recognize more frequent write-downs as suggested by these firms, the evidence does suggest that the implementation of Regulation SX 4-10 leads FC firms to recognize far more significant asset write-downs than those under SFAS 121 for SE firms. Table 3 reports the Pearson and Spearman correlations among the variables for the full sample and for each of the SE and FC sub-samples. The correlations between share price per SD and each of our independent variables are statistically significant. Note that the correlations between lagged O&G operating assets and both book value and cash investments are high which may affect the stability of the coefficient estimates on these variables.

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[11] Chen and Lee (1995), for instance, reported median ratios of the FC ceiling test write-down amount to pre-write-down total assets and equity of 12% and 29% respectively for their sample of 60 write-downs during 1985-1986. Also, Alciatore et al. (2000) report that the FC ceiling test write-downs represent an average of 23.9% (a median of 12.7%) of pre-write-down total assets for their sample of 148 write-downs during 1985-1986. Finally, Frost and Bernard (1989) report an average ratio of write-down to pre-write-down assets (equity) of 11% (41%) for their sample of 18 FC firms that recorded a write-down in the first quarter of 1986.

Table 3
Pearson and Spearman Correlations Among Variables Used in the Regression Models During the Sample Period 1995-2004

P is the market value of equity. BV is the book value of equity. E is comprehensive earnings. CI is net cash investments in operating assets. OG_OA is net capitalized O&G property, plants and equipments. Non-OG_OA is net non-O&G operating assets. All variables are deflated by standardized measure of O&G reserve value at the beginning of the year. (t denotes quarter and i denotes firm).

Panel A: Total Sample Firms (n = 2243)

	$P_{i,t}$	$BV_{i,t}$	$E_{i,t}$	$CI_{i,t-1}$	$OG\_OA_{i,t-1}$	$Non\text{-}OG\_OA_{i,t-1}$	
$P_{i,t}$		0.66	0.18	0.28	0.43	0.31	
P-value		0.00	0.00	0.00	0.00	0.00	
$BV_{i,t}$	0.73		0.16	0.40	0.73	0.30	
P-value	0.00		0.00	0.00	0.00	0.00	
$E_{i,t}$	0.41	0.38		0.01	-0.01	0.04	
P-value	0.00	0.00		0.66	0.61	0.09	
$CI_{i,t-1}$	0.58	0.54	0.21		0.46	0.19	
P-value	0.00	0.00	0.00		0.00	0.00	
$OG\_OA_{i,t-1}$	0.74	0.74	0.24	0.54		0.24	
P-value	0.00	0.00	0.00	0.00		0.00	
$Non\text{-}OG\_OA_{i,t-1}$	0.33	0.28	0.18	0.21	0.24		
P-value	0.00	0.00	0.00	0.00	0.00		

Pearson Correlation

Spearman Correlation

Panel B: Successful Efforts Firms (n = 1131)

	$P_{i,t}$	$BV_{i,t}$	$E_{i,t}$	$CI_{i,t-1}$	$OG\_OA_{i,t-1}$	$Non\text{-}OG\_OA_{i,t-1}$	
$P_{i,t}$		0.71	0.18	0.31	0.61	0.28	
P-value		0.00	0.00	0.00	0.00	0.00	
$BV_{i,t}$	0.78		0.11	0.44	0.82	0.34	
P-value	0.00		0.00	0.00	0.00	0.00	
$E_{i,t}$	0.40	0.35		-0.04	-0.09	0.02	
P-value	0.00	0.00		0.21	0.01	0.67	
$CI_{i,t-1}$	0.54	0.51	0.19		0.43	0.28	
P-value	0.00	0.00	0.00		0.00	0.00	
$OG\_OA_{i,t-1}$	0.71	0.88	0.28	0.52		0.34	
P-value	0.00	0.00	0.00	0.00		0.00	
$Non\text{-}OG\_OA_{i,t-1}$	0.27	0.29	0.09	0.21	0.24		
P-value	0.00	0.00	0.03	0.00	0.00		

Pearson Correlation

Spearman Correlation

Table 3, continued

Panel C: Full Cost Firms (n = 1112)							
	$P_{i,t}$	$BV_{i,t}$	$E_{i,t}$	$CI_{i,t-1}$	$OG\_OA_{i,t-1}$	$Non\text{-}OG\_OA_{i,t-1}$	
$P_{i,t}$		0.74	0.19	0.31	0.59	0.33	
P-value		0.00	0.00	0.00	0.00	0.00	
$BV_{i,t}$	0.81		0.11	0.41	0.72	0.39	
P-value	0.00		0.00	0.00	0.00	0.00	
$E_{i,t}$	0.41	0.40		-0.00	-0.08	0.02	
P-value	0.00	0.00		0.21	0.01	0.67	
$CI_{i,t-1}$	0.63	0.64	0.31		0.48	0.23	
P-value	0.00	0.00	0.00		0.00	0.00	
$OG\_OA_{i,t-1}$	0.60	0.78	0.27	0.59		0.33	
P-value	0.00	0.00	0.00	0.00		0.00	
$Non\text{-}OG\_OA_{i,t-1}$	0.31	0.31	0.24	0.28	0.17		
P-value	0.00	0.00	0.03	0.00	0.00		
Spearman Correlation							***Pearson Correlation***

Empirical Findings

Table 4 provides the coefficient estimates for the regression outlined in equation 2 for all observations during 1995-2004. The coefficient estimates on book value and comprehensive earnings are positive and statistically significant at conventional levels. Interestingly, the coefficient estimate on comprehensive earnings of SE firms (1.57 with a t-stat of 4.28) is significantly larger at statistically conventional levels than that of FC firms (0.80 with a t-stat of 2.29). On the other hand, the coefficient estimate on book value of FC firms (1.81 with a t-stat of 29.68) is significantly larger at statistically conventional levels than that of SE firms (1.44 with a t-stat of 15.82). While this evidence contradicts earlier O&G studies which show that the coefficient on book value of SE firms is significantly larger than that of FC firms (Harris and Ohlson 1987 and Bandyopadhyay 1994), we note that these studies use valuation models based on Ohlson (1995) which assumes unbiased accounting and does not allow or control for divergent levels of accounting conservatism by O&G producing firms.

The coefficient estimates on cash investments in operating assets for the full sample and for each of the FC and SE sub-samples are all positive and significantly different from zero at statistically conventional levels. This evidence suggests that accounting by O&G producing firms is conservative with

respect to investments in positive NPV activities.[12] Similar observations can be made about the coefficient estimates on lagged non-O&G operating assets, suggesting that accounting is conservative with respect to non-O&G operating assets.

The Impact of Asset-Impairment Rules on Accounting Conservatism

Hypothesis 1 proposes that, on average, accounting for O&G operating assets by O&G firms is unbiased or conservative. Table 4 shows that the estimates of the coefficients on lagged operating O&G assets are positive and significant for the entire sample and for each of the FC and SE sub-samples, suggesting conservative accounting estimates for O&G operating assets. Interestingly, the coefficient estimate on lagged operating O&G assets for FC firms (0.12 with a t-stat of 2.33) is significantly larger at statistically conventional levels than that of SE firms (0.02 with a t-stat of 2.08), suggesting that Regulation SX 4-10 results in more conservative O&G asset measures than those obtained under SFAS 121 for SE firms. This finding may be attributed to Regulation SX 4-10's requirements that FC firms test for asset impairments on a quarterly basis and use quarter-end prices and costs when calculating write-downs. As observed earlier, FC firms recognize far larger O&G asset write-downs than SE firms. Larger asset write-downs lead FC firms to have what we label a "write-down cushion" which in turn results in increased accounting conservatism when O&G prices rebound in subsequent periods.

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[12] This evidence stands in contrast to the findings of McConnell and Muscarella (1985), Picchi (1985), and Spear (1994). All of these studies use samples from earlier periods. We attribute this finding to changes in economic and operational conditions facing the industry during our sample period relative to those of prior studies. For example, the improvement in the efficiency of exploration activities (due to technological advances) is expected to contribute to the improvement in NPV prospects. Nichols and Boone (1995) provide evidence consistent with O&G firms achieving greater efficiency associated with their exploration activities, contributing to higher returns on exploration expenditures over time.

Table 4
Accounting Conservatism in the Oil and Gas Industry

Coefficient Estimates for the Regression

P is the market value of equity. BV is the book value of equity. E is comprehensive earnings. CI is net cash investments in operating assets. OG_OA is net capitalized O&G property, plants and equipments. Non-OG_OA is net non-O&G operating assets. All variables are deflated by standardized measure of O&G reserve value at the beginning of the year. (t denotes quarter and i denotes firm).

$$P_{i,t} = \alpha_{i,t} + \beta_1 BV_{i,t} + \beta 2\, E_{i,t} + \beta 3\, CI_{i,t} + \beta 4\, OG\_OA_{i,t-1} + \beta 5\, Non\text{-}OG\_OA_{i,t-1} + \epsilon_{i,t}$$

	α	$BV_{i,t}$	$E_{i,t}$	$CI_{i,t}$	$OG\_OA_{i,t-1}$	$Non\text{-}O\_OA_{i,t-1}$	R^2	n
Panel A: Total Observations								
Coef.	2.94	1.63	1.23	0.34	0.08	1.09	0.62	2243
t-stat	8.87	31.69	4.88	2.47	2.21	6.32		
Panel B: Successful Efforts Observations								
Coef.	3.76	1.44	1.57	0.27	0.02	0.60	0.56	1131
t-stat	7.77	15.82	4.28	2.33	2.08	1.85		
Panel C: Full Cost Observations								
Coef.	1.71	1.81	0.80	0.43	0.12	1.38	0.69	1112
t-stat	3.87	29.68	2.29	2.34	2.33	7.39		

The Impact of Asset Write-Downs on Accounting Conservatism

Hypothesis 2 proposes that accounting for O&G assets is unbiased at the end of write-down quarters and conservative otherwise. In order to gain further insights into the impact of asset write-downs on accounting estimates, Sections II and III of Table 5 provide the coefficients for the regression outlined in equation 2 during periods of (1) zero, and (2) non-zero, write-downs. The coefficient estimate on lagged O&G operating assets for the full sample during zero write-down periods is 0.14 with a t-stat of 2.95, suggesting that accounting estimates of O&G assets during these periods is conservative. The equivalent coefficient during non-zero write-down periods is -0.12 with a t-stat of -1.06 suggesting that accounting for O&G assets during these periods is unbiased. Combined, these results support hypothesis 2 and suggests that asset write-downs eliminate accounting aggressiveness and result in unbiased accounting

for O&G assets at the end of write-down quarters. The presence of conservative accounting during zero write-down quarters also confirms the asymmetric nature of asset-impairment rules.

Table 5
The Impact of Oil and Gas Asset Write-Downs on Accounting Conservatism

Coefficient Estimates for the Regression

$$P_{i,t} = \alpha_{i,t} + \beta_1 BV_{i,t} + \beta_2 E_{i,t} + \beta_3 CI_{i,t} + \beta_4 OG\_OA_{i,t-1} + \beta_5 Non-)OG\_OA_{i,t-1} + \varepsilon_{8,t}$$

P is the market value of equity. BV is the book value of equity. E is comprehensive earnings. CI is net cash investments in operating assets. OG_OA is net capitalized O&G property, plants and equipments. Non-OG_OA is net non-OG operating Assets. All variables are deflated by beginning of year standardized measure of the value of O&G reserves. (t denotes quarter and i denotes firm).

	α	$BV_{i,t}$	$E_{i,t}$	$CI_{i,t}$	$OG\_OA_{i,t-1}$	Non-$OG\_OA_{i,t-1}$	R^2	n
Section I: Zero write-down quarters								
Panel A: Total Observations								
Coef.	1.18	1.49	1.34	1.10	0.14	0.94	0.69	1913
t-stat	2.82	17.39	3.01	5.85	2.95	3.77		
Panel B: Successful Efforts Observations								
Coef.	1.61	1.29	1.67	0.51	0.11	1.20	0.66	892
t-stat	2.61	9.60	4.33	2.69	2.86	2.55		
Panel C: Full Cost Observations								
Coef.	1.89	1.84	0.80	0.35	0.28	1.05	0.66	1021
t-stat	3.09	22.69	2.68	2.31	3.34	3.45		
Section II: Write-down quarters								
Panel A: Total Observations								
Coef.	4.12	1.60	1.17	0.02	-0.12	1.39	0.58	330
t-stat	7.91	22.48	3.63	0.10	-1.06	5.79		
Panel B: Successful Efforts Observations								
Coef.	5.22	1.35	2.00	0.35	-0.06	0.47	0.50	239
t-stat	6.98	10.08	2.80	1.19	-1.08	1.06		
Panel C: Full Cost Observations								
Coef.	1.39	1.66	1.09	0.55	0.04	1.76	0.72	91
t-stat	2.12	14.41	1.99	2.12	0.70	6.84		

Consistent with our earlier findings, the coefficient estimate on lagged operating O&G assets for FC firms during zero write-down periods is 0.28 with a t-stat of 3.34 and is significantly larger at statistically conventional levels than that for SE firms (0.11 with a t-stat of 2.86), reflecting the impact of the write-down cushion by FC firms. While the coefficient on lagged operating O&G assets by FC firms during write-down quarters is positive (0.04), it is not significantly different from zero at statistically conventional levels.

As suggested in hypothesis 3a, it remains possible that asset write-downs resulting from the application of Regulation SX 4-10 during periods when O&G prices decline significantly lead to conservative accounting. During 1995-2004, oil prices fluctuated considerably. The mean percentage change in oil prices was 1 percent with a standard deviation of 14 percent and a range between -22 and 37 percent. To test hypotheses 3a and 3b, we re-estimate the coefficients of the regression outlined in equation 2 as follows:

$$P_{i,t} = \alpha_{i,t} + \beta_1 BV_{i,t} + \beta 2\, E_{i,t} + \beta 3\, CI_{i,t} + \beta 4\, OG\_OA_{i,t-1} + \beta 5\, non\_OG\_OA_{i,t-1} + \beta 6\, D_t + \beta 7\, (OG\_OA_{i,t-1}) \times D_t + \epsilon_{i,t} \quad (3)$$

Where,

D is dummy variable with a value of 1 if the percentage decline in oil prices during the quarter exceeds 15 percent, and 0 otherwise.

Table 6 provides the coefficient estimates for the regression outlined in equation 3. The estimate on the coefficient for lagged operating O&G assets during write-down periods when O&G prices decline significantly (B7) for SE firms is positive but not significantly different from zero. In addition, the sum of B4 and B7 is not significantly different from zero at statistically conventional levels. Supporting H3b, these statistics suggest that accounting for O&G assets by SE firms during write-down periods remains unbiased even when O&G prices decline significantly. On the other hand, the estimate on the equivalent coefficient for FC firms is positive and significant (0.15 with a t-stat of 2.77). In addition, the sum of B4 and B7 is positive and significantly different from zero at statistically conventional levels. These statistics clearly suggest that accounting for O&G assets by FC firms is conservative during write-down quarters when O&G prices decline significantly. This evidence supports the claims by FC firms that write-downs resulting from the application of Regulation SX 4-10 during periods when O&G prices decline significantly are overstated and lead to conservative accounting estimates for O&G assets.

Table 6

The Impact of Extreme Oil and Gas Price Decline on Accounting Conservatism During Write-Down Quarters

Coefficient Estimates for the Regression

$$P_{i,t} = \alpha_{i,t} + \beta_1 BV_{i,t} + \beta_2 E_{i,t} + \beta_3 CI_{i,t} + \beta_4 OG\_OA_{i,t-1} + \beta_5 non - OG\_OA_{i,t-1} + \beta_6 D_t + \beta_7 (OG\_OA_{i,t-1}) x D_t + \varepsilon_{i,t} \qquad (3)$$

P is the market value of equity. BV is the book value of equity. E is comprehensive earnings. CI is net cash investments in operating assets. OG_OA is net capitalized O&G property, plants and equipments. Non-OG_OA is net non-O&G operating Assets. D is dummy variable with a value of 1 if the percentage decline in oil prices during the quarter exceeds 15%, and 0 otherwise. All variables are deflated by beginning of year standardized measure of the value of O&G reserves. (t denotes quarter and i denotes firm).

	α	$BV_{i,t}$	$E_{i,t}$	$CI_{i,t}$	$OG\_OA_{i,t-1}$	Non-OG_ $OA_{i,t-1}$	D_t	$OG\_OA_{i,t-1} \times D_t$	R^2	n
Panel A: Successful Efforts Observations										
Coef.	5.15	1.33	2.01	0.34	-0.09	0.46	-2.11	0.37	0.55	239
t-stat	6.15	10.28	2.85	1.18	-1.28	1.05	-2.86	1.16		
Panel B: Full Cost Observations										
Coef.	1.25	1.68	1.19	0.59	0.01	1.77	-1.98	0.15	0.75	91
t-stat	2.44	14.32	1.93	2.01	0.65	6.25	-3.80	2.77		

Summary

We provide evidence consistent with unbiased accounting by FC and SE firms at the end of write-down quarters, suggesting that asset-impairment rules eliminate accounting aggressiveness by O&G firms when events suggest the presence of impairments. We also show evidence consistent with conservative accounting by FC and SE firms during non write-down periods consistent with the asymmetric nature of asset-impairment rules.

We then test the validity of the claims made by FC firms that Regulation SX 4-10 and in particular the requirement to use period-end O&G prices to calculate the ceiling estimates leads to conservative accounting estimates of O&G assets when O&G prices decline significantly. We show that, on average, accounting estimates for O&G assets by FC firms under Regulation SX 4-10 are more conservative than those by SE firms under SFAS 121 and that the

application of Regulation SX 4-10 leads to overstated asset write-downs during periods when O&G prices decline significantly.

On December 29, 2008, the SEC revised Regulation SX 4-10 to allow FC firms the use of an average price based upon the prior 12-month period rather than period-end prices in the ceiling calculations (SEC Release 33-8995 31 December 2008). The SEC argues that this change in policy aims to enhance the comparability between firms' reserve disclosures and to mitigate the variability associated with a single-day (period-end) price may have on reserve estimates (and hence asset write-downs). It remains the case however that the new rules still adopt the use of historical O&G prices in the ceiling calculations. While our findings suggest that the use of future O&G prices (by SE firms) vis-à-vis historical or current O&G prices (by FC firms) leads to unbiased accounting at balance sheet date, the SEC rejected the use of future O&G prices as a basis for the calculation of reserve estimates (and hence asset write-downs) arguing that the objectives of the ceiling test calculations (and hence asset write-downs) are not designed nor intended to represent a fair valuation of O&G assets.

We argue that the recent amendments to Regulation SX 4-10 might exaggerate rather than mitigate the variability associated with asset write-downs and their value relevance during periods when O&G prices decline significantly. Interestingly, the SEC recognized that the use of a 12-month average price could have the effect of requiring FC firms to record a ceiling test write-down during periods of rising O&G prices and could also result in the deferral of ceiling test write-downs in periods of declining O&G prices.

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