THE ACCOUNTING REVIEW
Vol. 74, No. 3
July 1999
pp. 251–280

Early Evidence on the Informativeness of the SEC's Market Risk Disclosures: The Case of Commodity Price Risk Exposure of Oil and Gas Producers

Shivaram Rajgopal
University of Washington

ABSTRACT: The paper provides early evidence on the informativeness of commodity price risk measures required by the Securities and Exchange Commission's new market risk disclosure rules (SEC 1997). I use existing disclosures of oil and gas producers (O&G) to obtain proxies for the tabular and sensitivity analysis disclosures required by the new SEC rules. I find that proxies for the tabular and the sensitivity analysis format are significantly associated with O&G firms' stock return sensitivities to oil and gas price movements. This finding casts doubt on claims that the new market risk disclosures do not reflect firms' risk exposures. The proxies for the tabular format and sensitivity format disclosures are not substitutable explanations of firms' risk exposures. This evidence suggests that disclosures from one disclosure format are not comparable to those from the other reporting format.

Key Words: *Derivatives disclosure, Market risk, Oil and Gas, SEC.*

This paper is based on my dissertation completed at the University of Iowa. I am especially grateful to my advisor, Dan Collins, for his guidance. I would like to thank my committee members, Mort Pincus, Charles Wasley, Anand Vijh and Forrest Nelson for their comments. I am grateful to two anonymous referees for their valuable suggestions. The paper has greatly benefited from discussions with Ramji Balakrishnan, Dave Burgstahler, Terry Shevlin and Mohan Venkatachalam. I would also like to thank David Aboody, Shlomo Benartzi, Tom Linsmeier, Joshua Livnat, K. Ramesh, Steve Ryan, D. Shores, Jim Wahlen and workshop participants at the University of California, Los Angeles, Carnegie Mellon University, Emory University, University of Iowa, Indiana University, University of Minnesota, New York University, Penn State University, University of Pittsburgh, Washington University and the University of Washington for their comments. I thank Walter Teets at the Securities Exchange Commission for providing access to the report released by the Senate Subcommittee on Securities on April 21, 1997.

Submitted August 1998.
Accepted March 1999.

Data Availability: *A list of sample firms is available from the author. The data used in the study can be obtained from public sources.*

I. INTRODUCTION

In this paper, I provide early evidence that commodity price risk disclosures similar to those required by the Securities and Exchange Commission's new market risk disclosure rules (hereafter, SEC 1997) are associated with stock market-based measures of commodity price risk exposure.[1] Effective June 15, 1998, SEC (1997) requires companies to disclose quantitative information about their market risk exposure stemming from derivatives and underlying nonderivative items. Firms are free to choose one of three reporting options to make these disclosures: (1) tabular presentation (describing fair value and contract terms), (2) sensitivity analysis (describing potential change in fair values and other losses under various market fluctuations) and (3) value at risk (describing a summary statistical measure of potential loss within a historical context).

While the SEC concludes that such "quantitative disclosures should help investors better understand specific market risk exposures of different registrants" (SEC 1997, 6048), critics have argued that quantitative market risk disclosures are likely to be unreliable and plagued with measurement problems. Logan and Montgomery (1997) testified before a U.S. Senate Subcommittee on SEC (1997) that "under the SEC rule, investors are unlikely to understand a company's derivative use and risk any better; in fact, the disclosures could be misleading." Echoing similar concerns, the AICPA has ruled that the sensitivity analysis disclosure alternative is too dependent on assumptions and hypothetical information for accountants to be able to certify the accuracy of such disclosures in comfort letters to underwriters (AICPA 1998).

Concerns have also been expressed that providing firms with three options for quantitative market risk reporting is likely to limit investors' ability to compare one firm with another and consequently affect the usefulness of the new disclosures. For example, Lehn (1997) testified before the Senate Subcommittee that the "menu of disclosure options calls into question how helpful the disclosed information will be to investors." The U.S. Senate Subcommittee (1997) noted that two similar companies, with very similar derivatives portfolios and strategies, could have very different quantitative analyses because of the alternative reporting options allowed.

There are two important questions related to the new disclosure requirements: (1) Are the SEC (1997) market risk disclosures associated with market-based measures of exposure? (2) Are risk disclosures from one format comparable with disclosures from another format? However, there are limitations on our ability to answer these two questions. Question (1) cannot now be evaluated with firm disclosures under SEC (1997) because these data are not yet available. Question (2) cannot be evaluated with firm disclosures under SEC (1997) even when such data become available because firms are unlikely to make disclosures under more than one allowed format. I provide early evidence on question (1) and relevant evidence on question (2). To provide such evidence, I use currently available information on oil and gas (O&G) firms as proxies for some disclosures required under SEC (1997) and determine whether these proxies are associated with firms' stock-price sensitivity to the risk associated with changes in oil and gas prices. In particular, I focus on a sample of O&G

[1] SEC (1997, 6044) defines market risk as the risk of loss arising from adverse changes in market rates and prices, such as interest rates, foreign currency rates, commodity prices and similar market rate or price changes (e.g., equity prices).

producers and assess whether risk measures generated from Statement of Financial Accounting Standards (SFAS) No. 69, *Disclosures about Oil and Gas Producing Activities* and SFAS No. 119, *Disclosures about Fair Values of Derivative Financial Instruments and Fair Values of Financial Instruments* (FASB 1982, 1994) are associated with O&G firms' stock-price sensitivities to changes in oil and gas prices (hereafter, oil and gas betas). Focusing on O&G firms is advantageous because they have relatively clear price risk exposures that are commonly managed with derivative commodity instruments. Moreover, O&G firms report measures of derivative use and underlying commodity price risk exposure under SFAS No. 119 and SFAS No. 69, respectively.[2] Such measures proxy for the required SEC (1997) disclosures.

In this paper, commodity price risk disclosures are evaluated based upon their ability to reflect firms' exposures to commodity price risk. The O&G firms in my sample do not ordinarily disclose whether they view commodity price risk exposure in terms of changes in fair values, future earnings, or future cash flows. The tests in this paper examine the association between commodity risk disclosures and the sensitivities of firm equity returns to changes in oil and gas prices. These tests evaluate the commodity price risk disclosures given that commodity price risk exposure is measured by changes in fair value. I have chosen to emphasize the changes in fair value perspective of commodity price risk exposure for three reasons. First, fair values already capture (present values) of future earnings and future cash flows, albeit with some measurement error. Second, data adapted from SFAS No. 69 and SFAS No. 119 disclosures can be readily used to empirically measure fair value exposure. However, data to estimate the sensitivity of future earnings to oil and gas price changes are not readily available. Third, available disclosures restrict my ability to unambiguously infer whether firms define exposure in terms of future cash flows, future earnings, or fair values. The mean sample firm hedges a small portion of its reserves (3.86 percent of oil reserves and 7.81 percent of gas reserves) suggesting that firms possibly hedge earnings and cash flows from next year's production. However, there is evidence to indicate that sample firms consider longer term exposures as well. For instance, 63 percent of the derivative contracts in the sample are written to hedge reserves for more than one year with some contracts valid for ten years into the future. Further, Clinch and Magliolo (1992) show that proven reserves to be produced as far down as three years from now are positively associated with current year's oil price sensitivities. Such evidence of long-term exposures provides some justification for defining exposures in terms of fair value. The consequences of evaluating disclosures by their ability to reflect the exposure of the firm to fair values changes because of changes in oil and gas prices need to be kept in mind. For example, the absence of an association between a monitored disclosure and the sensitivities of firm returns to oil and gas prices would not suggest that the monitored disclosure would fail to reflect risk exposure if exposure is thought of in terms of changes in earnings or cash flows.

The tests in the paper concentrate on commodity price risk disclosures under two alternate disclosure formats required by SEC (1997): tabular disclosure and sensitivity analysis.[3] The tabular format requires firms to disclose fair values of derivative commodity instruments and enough information about the contract terms to estimate expected cash flows. SEC (1997) encourages firms to disclose similar information voluntarily about their

[2] Underlying price risk exposure refers to the exposure that stems from nonderivative items.

[3] Although SEC (1997) allows firms to choose the value-at-risk format, credible proxies for value-at-risk measures are not readily available from extant financial statements of my sample firms. Such data requires frequent time-series observations of the fair values of a firm's commodity derivatives, its underlying exposures and operating factors that affect such fair value changes (see, Linsmeier and Pearson 1997).

underlying commodity price risk exposure. The stated goal of tabular information is to allow users to make their own assessments of a firm's market risk exposure. In this study, the notional values of hedged reserves reported under SFAS No. 119 represent one component of the contract terms that investors would use to estimate the expected cash flows of the derivative commodity instruments.[4] Proven oil and gas reserves reported per SFAS No. 69 valued at year-end oil and gas prices are used to proxy for the firm's commodity risk exposures under the tabular format of risk disclosures. For a sample of 149 firm-years for the period 1993 to 1996, I find that the proxy for tabular format measures of commodity derivative activity is negatively associated with firms' oil and gas betas. The proxy for the tabular format measures of underlying exposure, namely proven reserves, exhibits positive significant associations with oil and gas betas only for those firms whose proven reserve estimates are perceived by the market to contain less measurement error than the estimates of the median firm.

The sensitivity analysis format of SEC (1997) requires firms to report explicit estimates of fair value gains and losses on derivative commodity instruments due to changes in the prices of the underlying commodity. In addition, the SEC encourages firms to voluntarily present fair value gains and losses on the underlying exposure due to changes in prices. In this paper, I use SFAS No. 119 disclosures of fair value gains and losses on O&G derivative instruments as a firm-specific estimate of the commodity price sensitivity of derivative commodity instruments. I use the oil and gas price-induced change in the SFAS No. 69 present values of future cash flows to estimate the price sensitivity of the underlying exposure. For a subsample of 89 firm-years over the period 1993 to 1996, I find that these proxies for the fair value sensitivity of underlying exposure (commodity derivatives) exhibit significant positive (negative) association with oil and gas betas. This finding is not consistent with claims made in comment letters (SEC, 1997, IV[4]) and the position taken by AICPA (1998) that sensitivity analysis disclosures do not reliably measure firms' market risk exposures.

I find that the sensitivity analysis proxies and the tabular disclosure proxies each possess incremental utility for explaining oil and gas betas. Hence, the information from the two different disclosure formats are not complete substitutes for one another; they each reflect different aspects of firm risk exposures as captured by oil and gas betas. This finding is consistent with concerns expressed by the U.S. Senate Subcommittee (1997) that the choice among alternative forms of quantitative disclosures may limit comparability among companies. As stated earlier, this analysis is especially important because it cannot be readily conducted later using official SEC (1997) disclosures as firms are not required to report risk exposures under more than one disclosure format.

Overall, the paper's results confirm that the commodity price risk disclosures similar to those required by SEC (1997) are, in general, associated with the market's perception of oil and gas price sensitivity. The interpretation of this association is subject to the same cautions that apply to all association results. The association of SEC (1997)-like risk measures with firms' oil and gas price sensitivities has to be viewed as a necessary, but not sufficient, condition for the usefulness of such disclosures. Such association, by itself, does not demonstrate the incremental utility of these risk measures to investors. For example, equivalent information may be available to the market from sources other than the footnote disclosures used in the paper. It is also unclear whether financial statement disclosure is

---

[4] The notional value of a derivative contract represents the face or the contractual value of such a contract. Fair value of a derivative represents the present values of the amounts that the firm is expected to receive or pay on the derivative contract.

the most cost-effective source of this information. However, early evidence that some risk measures that proxy for the disclosures required by SEC (1997) are associated with firms' underlying exposures does suggest that the disclosures will not be misleading as some critics have claimed.

The remainder of the paper is organized as follows. Sections II and III outline the research designs for testing the association between oil and gas betas with the tabular and sensitivity analysis disclosures of firms' net commodity price risk exposure. Section IV describes the sample and data used in the paper. Section V reports the results, and section VI concludes.

II. TABULAR FORMAT DISCLOSURES

The tabular disclosure alternative requires presentation of information about fair values and contract terms sufficient to determine the expected cash flows of derivative commodity instruments outstanding at the end of a reporting period. The stated goal of the tabular disclosure format is to allow users to derive their own estimates of a firm's market risk exposure (SEC 1997, 6049). The sample tabular disclosure suggested by SEC (1997) for commodity price sensitivity (adapted for O&G producers) is reproduced in exhibit 1. The sample disclosure format provides an example of how an O&G firm might comply with disclosure requirements under the tabular format. As shown, companies may report the notional quantity of oil and gas sold forward using a futures contract, the weighted average settlement price per unit of oil and gas sold forward, the notional value and the fair value of the futures contract. The sample disclosure also includes a voluntary disclosure of the carrying amount and fair value of underlying oil and gas proven reserves.

Under the tabular format, a firm's underlying exposure is estimated as the fair value of its proven oil and gas reserves.[5] I express the portion of the market value of a firm's equity that is sensitive to oil and gas price changes as the sum of the fair value of proven reserves and the fair value of commodity derivatives. Thus, I assume that the contribution to a firm's equity value from items other than proven reserves and commodity derivatives is independent of changes in oil and gas prices and, hence, forms part of the firm-specific error term. I then derive a parsimonious empirical relation between the sensitivity of equity values to changes in oil and gas prices and two contract terms related to underlying exposure and derivatives that may be presented under the tabular format: (1) proven oil and gas reserves valued at year-end spot oil and gas prices and (2) the notional value of oil and gas sold forward using derivative contracts. I expect significant associations between the sensitivity of equity values to changes in oil and gas prices and the two items of tabular information if the items reflect commodity risk or firm efforts to reduce that risk.

An Empirical Relation Between Tabular Information and a Market-Based Measure of Risk Exposure

For simplicity, consider an O&G firm that has no gas reserves. At time t, the firm's market value of equity (MVE) is the sum of the fair value of its oil inventory proxied by proven oil reserves ($FV_{oil,u}$) and the fair value of its short oil derivatives position ($FV_{oil,d}$) and an error term representing components of MVE assumed to not vary with oil prices:

$$MVE_t = FV_{oil,u,t} + FV_{oil,d,t} + error_t. \quad (1)$$

[5] The adapted exhibit 1 lists the fair value of proven oil and gas reserves under the caption "on balance sheet exposure" although proven SFAS No. 69 reserve measures used in this study to proxy for fair value of proven oil and gas reserves are disclosed in footnotes and not on the balance sheet.

EXHIBIT 1
SEC's (1997) Tabular Disclosure Format for Commodity Price Sensitivity

The table below provides information about the Company's oil and gas inventory and futures contracts that are sensitive to changes in oil and gas prices. For inventory, the table presents the carrying amount and fair value at December 31, 19X1 of the firm's oil and gas reserves. For futures contracts, the table presents the notional amounts in barrels and million cubic feet, the weighted average contract prices and the total dollar contract amount by expected maturity dates, the latest of which occurs one year from the reporting date. Contract amounts are used to calculate the contractual payments and quantity of oil and gas to be exchanged under the futures contracts.

December 31, 19X1

	Carrying Amount (in millions)	*Fair Value (in millions)*
On-Balance-Sheet Commodity Position and Related Derivatives		
Oil Inventory[a]	$XXX	$XXX
Gas Inventory[a]	$XXX	$XXX
	Expected Maturity 19X2	*Fair Value*
Related Derivatives		
Oil Futures Contracts (Short):		
Contract volumes (100,000 barrels)	XXX	
Weighted Average Price (Per barrel)	$X.XX	
Contract Amount ($ US in millions)	$XXX	$XXX
Gas Futures Contracts (Short):		
Contract volumes (100,000 million cubic feet)	XXX	
Weighted Average Price (Per cubic foot)	$X.XX	
Contract Amount ($ US in millions)	$XXX	$XXX

[a] SEC (1997) encourages but does not mandate disclosure of the on-balance-sheet commodity position. On-balance-sheet commodity position refers to the underlying nonderivative items.

Consider the fair value of a firm's proven oil reserves. The Hotelling valuation principle (HVP), developed by Miller and Upton (1985a), has been used in prior research (e.g., Magliolo 1986; Clinch and Magliolo 1992) to express the fair value of a firm's reserves as a function of reserve quantity and current oil price. In particular, the Hotelling valuation principle states that the fair value of a firm's reserves is the product of its oil reserve quantity and current oil price (p_{oil}), net of current extraction cost (c):

$$FV_{oil,u,t} = (p_{oil,t} - c_t) \times \text{oil reserve quantity}_t. \quad (2)$$

Let Δp_{oil} be a small change in oil price from time t to t + 1. The corresponding change in the fair value of reserves from time t to time t + 1 ($\Delta FV_{oil,u}$), assuming that reserve quantity and extraction cost do not change in response to a small change in oil price, is:[6]

$$\Delta FV_{oil,u} = \Delta p_{oil} \times \text{oil reserve quantity}_t. \tag{3}$$

The fair value of a derivatives contract the firm uses to assume a short position in oil can be approximated as the product of the notional quantity of reserves sold short and the current oil price, net of the strike price of the derivatives contract (p_s):

$$FV_{oil,d,t} = (p_{oil,t} - p_s) \times \text{oil notional quantity-short}_t. \tag{4}$$

Because the strike price p_s is a constant, change in the fair value of the derivatives contract in response to a small change in oil price from time t to time t + 1 ($\Delta FV_{oil,d}$) is:[7]

$$\Delta FV_{oil,d} = \Delta p_{oil} \times \text{oil notional quantity-short}_t. \tag{5}$$

The next step is to combine the change in fair value of reserves and the derivatives contract into one expression:

$$\begin{aligned}\Delta MVE &= \Delta FV_{oil,u} + \Delta FV_{oil,d}\\ &= \Delta p_{oil} \times (\text{oil reserve quantity}_t + \text{oil notional quantity-short}_t).\end{aligned} \tag{6}$$

In equation (6), ΔMVE represents the change in market value of equity from time t to t + 1. Multiplying and dividing equation (6) by $p_{oil,t}/(MVE_t \times \Delta p_{oil})$ yields:

$$\begin{aligned}(\Delta MVE/MVE_t)/(\Delta p_{oil}/p_{oil,t}) &\equiv \text{stock price sensitivity to oil price changes from time t to t + 1}\\ &= (p_{oil,t} \times \text{oil reserve quantity}_t)/MVE_t\\ &\quad + (p_{oil,t} \times \text{oil notional quantity-short}_t)/MVE_t.\end{aligned} \tag{7}$$

It should be noted that although equation (7) is based on fair value of reserves (through equation [2]) and fair value of derivatives (through equation [4]), such fair values do not directly enter the model in equation (7).

In equation (7), stock price sensitivity at a point in time is defined to be a clear function of the value of its long position and the notional value of its short oil position. So for a firm, price sensitivities will vary across time if the value of its long and short positions change over time. The same intuition can be extended to a cross-sectional setting where firms with larger long positions and smaller short positions can be expected to have higher

[6] $\Delta FV_{oil,u}$ may be relatively insensitive to Δp_{oil} if the oil price level is close to or below the extraction cost. However, this is unlikely to be a major concern during my sample period, 1993 to 1996, because the average price per barrel of oil was $19.52, whereas the average industry-wide extraction cost per equivalent barrel of oil was $4.77 (Standard and Poor's Industry Survey 1997). Thus, during this period, typical oil and gas prices were far enough above typical extraction costs that change in reserve values would be linearly related to oil and gas price changes.

[7] Equation (5) is based on the premise that firms in the sample typically hold futures, forwards or swaps to assume short positions in oil. Evidence consistent with this premise is provided in section 4 (panel B of table 2). If options were more commonly used by firms to assume short positions in oil, Δp_{oil} and consequently $\Delta FV_{oil,d}$ may be zero at oil price levels below the floor oil price set by the option contract.

stock price sensitivities to oil prices. However, developing the specific equation to be estimated is complicated by the institutional features of the O&G industry and by such design issues as the frequency with which disclosure proxies are available, the time interval over which stock price sensitivity to oil prices can be estimated, and the desire to increase econometric efficiency in estimation. Hence, I develop the ideas behind the model actually tested (equation [11]) using a series of intermediate equations (8), (9) and (10) described in the following paragraphs.

Equation (8) converts the relation derived in equation (7) into a cross-sectional regression equation for j firms across y years. Equation (8) suggests that firm j's stock price sensitivity to oil price changes measured over a year y ($\beta_{oil,j,y}$) is explained by two factors underlying such sensitivity, i.e., the product of current oil prices and reserve quantities (value of proven oil reserves) held by firm j during year y and the product of current oil prices and derivative quantities (the notional value of oil derivatives-short) held by firm j during the year y:

$$\beta_{oil,j,y} = \delta_0 + \delta_r \text{ (value of proven oil reserves}_{j,y}/MVE_{j,y}) + \delta_d \text{ (notional value of oil derivatives-short}_{j,y}/MVE_{j,y}) + \varepsilon_{j,y}. \quad (8)$$

Relaxing the assumption that firms have no gas reserves, an expression similar to equation (8) can be derived for firms' stock price sensitivity to gas price changes measured over year y ($\beta_{gas,j,y}$):[8]

$$\beta_{gas,j,y} = \lambda_0 + \lambda_r \text{ (value of proven gas reserves}_{j,y}/MVE_{j,y}) + \lambda_d \text{ (notional value of gas derivatives-short}_{j,y}/MVE_{j,y}) + \varepsilon_{j,y}. \quad (9)$$

Coefficients $\beta_{oil,j,y}$ and $\beta_{gas,j,y}$ are predicted to be positive because O&G firms in my sample do not hedge all their oil and gas reserves (see table 2 panel A, for evidence). Turning to variables that explain $\beta_{oil,j,y}$ and $\beta_{gas,j,y}$ in equations (8) and (9), theory predicts that coefficients δ_r and λ_r on proven oil and gas reserves should be 1 whereas coefficients δ_d and λ_d on the notional value of oil and gas derivatives-short should be -1. Intercepts δ_0 and λ_0 should be zero if firms' stock price sensitivity to oil and gas price changes is explained fully by the firms' reserves and their derivative positions.

However, predictions about the magnitude of the stated coefficients are unlikely to hold when equations (8) and (9) are applied to the data. In particular, the intercepts δ_0 and λ_0 are not expected to be zero because factors other than reserves and derivative positions may influence $\beta_{oil,j,y}$ and $\beta_{gas,j,y}$. For example, $\beta_{oil,j,y}$ and $\beta_{gas,j,y}$ would vary cross-sectionally and inter-temporally as a function of different tax rates faced by firms (Clinch and Magliolo 1992). However, disclosures of proven reserves and derivative positions may not incorporate the effects of different tax structures across firms and across time for a given firm. Further, revisions in firms' competitive positions caused by oil and gas price-induced changes in future production and marketing strategies may vary cross-sectionally across firms and across time for a given firm (see Stulz and Williamson 1997). Although such revisions in competitive exposures would be embedded in stock market determined $\beta_{oil,j,y}$s and $\beta_{gas,j,y}$s, they may not be captured by my measures of firms' reserves and derivative positions.

[8] I effectively assume that oil price changes are not highly correlated with gas price changes. As an empirical matter the correlation between oil and gas returns is significant but small (0.07; $p = 0.01$).

For similar reasons, I expect coefficients δ_r and λ_r on reserve values to be positive (not exactly 1) and coefficients δ_d and λ_d on derivative notional values to be negative (not exactly -1). Three sources of measurement error constrain me to predict merely the signs and not the magnitudes of the coefficients on proven reserves and derivative positions. First, a predicted value of 1 for δ_r and λ_r relies on the descriptive validity of the Hotelling valuation principle. However, prior work has documented only mixed empirical evidence in support of the principle (see Alciatore 1990; Miller and Upton 1985a, 1985b; Clinch and Magliolo 1992). Second, I have to allow $\beta_{oil,j,y}$s and $\beta_{gas,j,y}$s to change only once a year when a firm reports annual measures of its proven reserves and derivative short positions although the theory developed in equation (7) imposes no such restriction. Third, as explained more fully below, $\beta_{oil,j,y}$s and $\beta_{gas,j,y}$s need to be estimated because they are not directly observable. A firm's $\beta_{oil,j,y}$ and $\beta_{gas,j,y}$ can be measured as the sensitivity of firms' stock returns to percentage changes in prices of a benchmark crude oil or natural gas. However, the changes in the price of the benchmark crude oil or natural gas may be a noisy proxy for the actual price changes experienced by each firm because a firm may have reserves and derivatives for many different grades and types of oil and gas. Therefore, I expect a positive statistically significant δ_r and λ_r and a negative statistically significant δ_d and λ_d if tabular disclosures of oil reserves and short-derivative positions are correlated with the information investors use in setting security prices.

The dependent variables $\beta_{oil,j,y}$ and $\beta_{gas,j,y}$ in equations (8) and (9) are not observable to the researcher but need to be empirically estimated. Oil and gas betas can be estimated by regressing the return for a firm j over m months (R_{jm}) in year y against three factors for year y: the holding period return on the market over m months ($MKTRET_m$), percentage changes in spot prices of a benchmark crude oil over m months ($\Delta OPRICE\%_m$), and the percentage change in the spot prices of a benchmark natural gas over m months ($\Delta GPRICE\%_m$).[9] Although using daily return data instead of monthly return data has the advantage of higher frequency of observations to measure $\beta_{oil,j,y}$ and $\beta_{gas,j,y}$, daily return data can introduce substantial asynchronous trading biases in the reported $\beta_{oil,y}$ and $\beta_{gas,y}$ measures, especially for infrequently traded stocks. Because a few O&G firms in the sample trade infrequently, with some not trading every day, I use monthly returns to calculate $\beta_{oil,j,y}$ and $\beta_{gas,j,y}$. The model, fitted for each firm j and year y, yields a series of firm j- and year y-specific estimates of market price reactions to changes in oil and prices over the year y:

$$R_{j,m} = \alpha_j + \beta_{mkt,j,y}\, MKTRET_m + \beta_{oil,j,y}\, \Delta OPRICE\%_m + \beta_{gas,j,y}\, \Delta GPRICE\%_m + \varepsilon_{j,m}. \quad (10)$$

Note that if equation (8) and equation (9) were estimated separately from equation (10), I would give the same weight to each estimated oil and gas beta regardless of its standard error. To address this inefficiency, I jointly estimate oil and gas betas along with the determinants of the betas in one specification. In particular, I combine the expressions in equations (8) and (9) for oil and gas betas with equation (10) and estimate the parameters in the following empirical specification where the time subscript on returns is now m to denote monthly returns and the time subscript on disclosure proxies is y to denote yearly measure of the variable. All reserve and derivative variables are scaled by market value of the firm

[9] The benchmark crude oil is a grade of oil known as "West Texas Intermediate" while the benchmark natural gas is known as "Henry Hub."

at the beginning of the year. Thus, equation (11) is estimated using a total of m × j firm-months in the sample:[10]

$$\begin{aligned} R_{j,m} = {} & \gamma_0 + \gamma_1 MKTRET_m + \gamma_2 \Delta OPRICE\%_m + \gamma_3 \Delta GPRICE\%_m \\ & + \gamma_4(\Delta OPRICE\%_m \times \text{value of proven oil reserves}_{j,y}/MVE_{j,y-1}) \\ & + \gamma_5(\Delta OPRICE\%_m \times \text{notional value of oil derivative-short}_{j,y}/MVE_{j,y-1}) \\ & + \gamma_6(\Delta GPRICE\%_m \times \text{value of proven gas reserves}_{j,y}/MVE_{j,y-1}) \\ & + \gamma_7(\Delta GPRICE\%_m \times \text{notional value of gas derivative-short}_{j,y}/MVE_{j,y-1}) \\ & + \varepsilon_{j,m}. \end{aligned} \tag{11}$$

Equation (11) is the empirical specification used to test the risk-relevance of tabular disclosures. The coefficients on the oil and gas return interaction terms in equation (11) γ_4, γ_5, γ_6 and γ_7 are analogous to δ_r, δ_d, λ_r and λ_d in equations (8) and (9). Therefore, I expect γ_4 and γ_6 to be positive and γ_5 and γ_7 to be negative if tabular disclosures of oil reserves and short-derivative positions are correlated with the information investors use in setting security prices. As discussed earlier, intercepts δ_0 from equation (8) and λ_0 from equation (9) are unlikely to be zero. Such nonzero intercepts from equations (8) and (9) would manifest themselves as nonzero γ_2 and γ_3 coefficients in equation (11). The oil and gas price interaction terms are scaled by market value of the firm at the beginning of the year. In equation (11), the value of proven oil reserves is measured as the product of SFAS No. 69 proven oil and gas reserve quantity and year-end spot oil and gas prices.[11] The notional value of oil and gas derivatives-short is measured as product of the quantity of oil and gas sold short and the weighted average price at which such oil and gas is sold short, both reported by firms at year-end per SFAS No. 119. Exhibits 2 and 3 illustrate how SFAS No. 69 and SFAS No. 119 disclosures are used to represent the constructs "value of proven oil or gas reserves" and "notional values of oil or gas derivatives-short" for a typical sample firm, Newfield Exploration Company.

III. SENSITIVITY ANALYSIS DISCLOSURES

Tabular disclosures do not directly state the potential loss resulting from commodity price risk. Investors have to infer potential loss using information provided about contract terms and cash flows of derivative commodity instruments and underlying oil and gas reserves. In contrast, the sensitivity analysis approach requires explicit estimates of the potential loss in future earnings, future cash flows or fair values that arise from derivative commodity instruments and encourages voluntary reporting of losses that arise from underlying commodity positions. O&G firms ordinarily do not make explicit disclosures of the potential losses arising from the sensitivity of their oil and gas reserves to price risk.

[10] This methodology is similar to that used in previous research (Tufano 1998; Collins and Venkatachalam 1997; Schrand 1997; Wong 1997; Pillof 1994; Nabar 1995) to document associations between accounting disclosures and a stock-market-based measure of net market risk exposure. The qualitative findings when the empirical specifications were reestimated using the portfolio time-series regression approach suggested by Sefcik and Thompson (1986) are similar to those reported in the paper. The tenor of inferences from the empirical specifications is unchanged when (1) weekly returns are used instead of monthly returns; (2) $\Delta OPRICE\%_m$ and $\Delta GPRICE\%_m$ are measured as percentage changes in oil and gas futures prices instead of spot prices; (3) percentage changes in six-month London Inter Bank Offer Rate (LIBOR) is included as an additional explanatory variable to control for changes in interest rates; and (4) the interaction of $\Delta OPRICE\%_m$ and $\Delta GPRICE\%_m$ with the reserve and derivative variables is scaled by market value of equity at year-end instead of market value of equity at the beginning of the year.

[11] The tenor of results is unchanged when average spot oil price is used in place of year-end spot oil price.

In the following subsection, I derive the predicted relation between a firm's oil and gas price sensitivity and the fair value changes in reserves and derivative positions. I also discuss the limitations of data adapted from SFAS No. 69 and SFAS No. 119 to measure the change in fair value of reserves and derivative positions and the impact of those limitations on the empirical model tested.

EXHIBIT 2
An Illustration of SFAS No. 69 Disclosures Drawn from the 1995 10-K of Newfield Exploration Company

SUPPLEMENTARY FINANCIAL INFORMATION
SUPPLEMENTARY OIL AND GAS DISCLOSURES-UNAUDITED
(paragraphs omitted)

Proved developed and undeveloped reserves	*Oil, Condensate and Natural Gas Liquids (MBbls)*	*Natural Gas (MMcf)*
December 31, 1994	8,610	153,967
Reserve changes during the year (details suppressed)	1,023	49,613
December 31, 1995	9,633	203,580

Notes:

For the year ended December 31, 1995:

1. Value of proven oil reserves for 9.633 million barrels at $19.55 per barrel (WTI spot price as of December 29, 1995, last trading day of 1995) is $188.32 million.
2. Value of proven gas reserves of 203,580 million cubic feet at $3.606 per thousand cubic feet (Henry Hub spot price as of December 29, 1995) is $734.1 million.
3. Quantity of oil (gas) proven reserve changes for 1995 is 1.023 million barrels (49,613 million cubic feet).

(paragraphs omitted)

A summary of the changes in standardized measure of discounted future net cash flows applicable to proved oil and gas reserves is as follows (in thousands):

	Year ended December 31, 1995
Beginning of the period	$180,002
Revisions of previous estimates:	
Changes in prices and costs (SFAS No. 69 price revisions)	61,917
Other reasons for the change (suppressed here)	34,407
End of period	$276,326

An Empirical Relation Between Fair Value Sensitivity Information and a Market-Based Measure of Risk Exposure

As before, consider an O&G firm with no gas reserves. The change in the market value of such a firm from time t to t + 1 (ΔMVE) can be expressed as a change in the fair value of underlying oil reserves ($\Delta FV_{oil,u}$) and change in the fair value of oil derivative positions ($\Delta FV_{oil,d}$):

$$\Delta MVE = \Delta FV_{oil,u} + \Delta FV_{oil,d}. \quad (12)$$

Multiplying and dividing equation (12) by $p_{oil,t}/(MVE_t \times \Delta p_{oil})$ yields:

$$\begin{aligned}(\Delta MVE/MVE_t)/(\Delta p_{oil}/p_{oil,t}) &\equiv \text{stock price sensitivity to oil price changes} \\ &\quad \text{from time t to time t + 1} \\ &= (\Delta FV_{oil,u}/MVE_t)/(\Delta p_{oil}/p_{oil,t}) \\ &\quad + (\Delta FV_{oil,d}/MVE_t)/(\Delta p_{oil}/p_{oil,t}). \quad (13)\end{aligned}$$

EXHIBIT 3
An Illustration of Commodity Derivatives Disclosures Drawn from the 1995 10-K of Newfield Exploration Company

1. Financial Instruments with Off-Balance-Sheet Risk

From time to time, the Company has utilized hedging transactions with respect to a portion of its oil and gas production to achieve a more predictable cash flow, as well as to reduce its exposure to price fluctuations.

(paragraphs omitted)

The following is a summary of the Company's gas swap positions as of December 31, 1995 and 1994.

	MMMBtu	*Period*	*Weighted Average Price (MMBtu)*	*Weighted Average Price (Mcf)*	*Fair Value Market*
December 31, 1995	15,000	January 1996–September 1996	$1.72	$1.83	($7.2 million)
December 31, 1994	11,150	January 1995–September 1995	$1.72	$1.84	$1.9 million

Oil. The Company has entered into sales contracts for approximately 421 barrels of oil production per day for the perod January 1996 through April 1996, which effectively fixed the Louisiana Light Sweet ("LLS") posted price for such production at $16.50 per barrel. Additionally, the Company has entered into a crude oil swap agreement for 1,000 barrels of oil production per day for the period January 1996 through June 1996, which effectively fixed the LLS posted price for such production at $15.25 per barrel.

Because substantially all of the Company's oil production is under spot contracts that reference to the LLS posted price, the Company has no basis risk with respect to these transactions.

The fair value of the crude oil swap agreement was a loss of approximately $0.4 million as of December 31, 1995.

(*Continued on next page*)

EXHIBIT 3 (Continued)

The opportunity loss will be substantially offset in the cash market when the hedged commodity is delivered in 1996, which has the effect of fixing the price at which the commodity is sold. The Company did not have any crude oil swaps in place at December 31, 1994.

2. *Management's discussion and analysis of hedging activities for the year ended December 31, 1995.*

(paragraphs omitted)

As a result of hedging activities for 1995, the Company realized a $2.7 million increase in revenues.

Notes: The empirical variables used to measure various aspects of derivatives' activity in equations (11), (17) and (18) are computed as follows:

1. Notional value of oil derivatives-short is the sum of	
Oil swaps: 182,000 barrels at $15.25 per barrel	$2.77 million
LLS contracts: 50,941 barrels at $16.50 per barrel	$0.84 million
	$3.61 million
2. Notional value of gas derivatives-short is measured as 15,000 trillion btu at $1.72 per million btu	$25.8 million
3. Fair value of traded derivatives is computed as	
Fair value of traded derivatives as of 12/31/1995	$(7.2) million
Less: Fair value of traded derivatives as of 12/31/1994	$1.9 million
Add (less): Realized gains (losses) on derivatives in 1995	$2.7 million
	$(6.4) million
4. OTC oil derivatives-short is the 50,941 barrels on the LLS contracts.	

In equation (13), stock price sensitivity at a point in time is defined to be a function of the fair value change of the firm's long position in underlying reserves and the fair value change of the firm's short position in derivatives. So for a firm, price sensitivities will vary across time if the fair value changes of its long and short positions change over time. The same intuition can be extended to a cross-sectional setting where firms with larger fair value changes in underlying reserves and smaller fair value changes in derivative positions can be expected to be associated with higher stock price sensitivities to oil prices. In the following paragraphs, I develop the ideas behind the model actually tested (equation [17]) using intermediate equations (14), (15) and (16).

Equation (14) below converts the relation derived in equation (13) into a cross-sectional regression equation for j firms across y years. Equation (14) suggests that $\beta_{oil,j,y}$, firm j's stock price sensitivity to monthly percentage in oil prices changes ($\Delta OPRICE\%_m$) over year y, is explained by fair value changes in underlying reserves and fair value changes in short-derivative positions for firm j during the year y:

$$\beta_{oil,j,y} = \eta_0 + \eta_r[(\Delta FV_{oil,u,j,y}/MVE_y)/\Delta OPRICE\%_m] + \eta_d[(\Delta FV_{oil,d,j,y}/MVE_y)/\Delta OPRICE\%_m] + \varepsilon_{j,y}. \quad (14)$$

Relaxing the assumption that firms have no gas reserves, an expression similar to equation (14) can be derived to explain firms' stock price sensitivity to gas price changes measured over year y ($\beta_{gas,j,y}$) in terms of fair value change in underlying gas reserves ($\Delta FV_{gas,u}$) and fair value change in gas derivative positions ($\Delta FV_{gas,d}$):

$$\beta_{gas,j,y} = \omega_0 + \omega_r[(\Delta FV_{gas,u,j,y}/MVE_y)/\Delta GPRICE\%_m] + \omega_d[(\Delta FV_{gas,d,j,y}/MVE_y)/\Delta GPRICE\%_m] + \varepsilon_{j,y}. \quad (15)$$

As before, $\beta_{oil,j,y}$ and $\beta_{gas,j,y}$ are predicted to be positive because O&G firms in the sample hold net long positions in oil and gas. I expect the intercept terms η_0 in equation (14) and ω_0 in equation (15) to be nonzero because my accounting measures of fair value changes on reserves and derivatives are unlikely to capture fully cross-sectional and inter-temporal differences in tax rates and competitive exposures. I merely predict the signs, not the magnitude, of coefficients related to the explanatory variables in equations (14) and (15) because of: (1) shortcomings in my fair value measures (explained more fully later); (2) the measurement error resulting from using price changes in a benchmark crude and natural gas to proxy for a firm's actual oil and gas prices; and (3) the need to allow $\beta_{oil,j,y}$ and $\beta_{gas,j,y}$ to vary only once a year in response to annually disclosed fair value information.

Turning to equations (14) and (15), I expect coefficients η_r and ω_r on the oil and gas price-induced fair value changes in reserves to be positive. Firms with greater fair value *gains* in reserves per unit of an *increase* in oil prices and gas prices would have higher β_{oil} and β_{gas}, respectively. Similarly, if oil prices decrease, firms with greater fair value *losses* in reserves per unit of a *decrease* in oil prices would have greater β_{oil} and β_{gas} coefficients, respectively.

Coefficients η_d and ω_d on the oil and gas price induced fair value changes in short derivative positions are expected to be negative. Notice that the directional predictions on η_d and ω_d are opposite the previously discussed predictions on η_r and ω_r. This is because the fair value changes of derivatives would be negatively associated with fair value changes of oil and gas reserves given that sample firms hedge less than 100 percent of their underlying reserves.[12] To illustrate this negative association, assume that the current oil price is equal to the strike price of a futures contract sold by the firm. An *increase* in oil prices would result in fair value *losses* on the firm's futures contract as against fair value *gains* in underlying reserves. Similarly, a *decrease* in oil prices would result in fair value *gains* on the firm's futures contract as against fair value *losses* in underlying reserves.

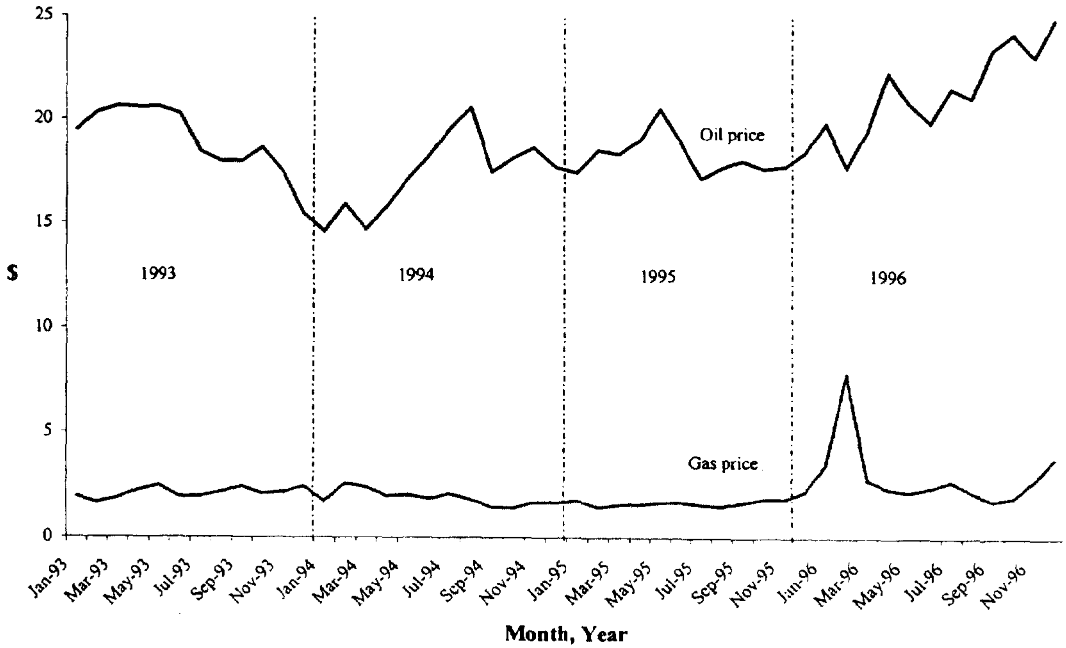
It is noteworthy that equations (14) and (15) can be applied to a pooled data set containing periods of increasing and/or decreasing oil and gas prices. The ability to pool data over different price environments is important because my sample period 1993 to 1996 is characterized by both increases and decreases in oil and gas prices (see figure 1). Pooling across different price environments is possible because the ratio of fair value changes in oil and gas reserves (derivatives) scaled by percentage changes in oil and gas prices is expected to be positive (negative) irrespective of the direction of the oil and gas price change.

As before, equations (14) and (15) can be combined into the three-factor model described in equation (10). The resulting equation (16) can be estimated using monthly returns:

---

[12] The correlation between SFAS No. 69 price revisions (my measure of fair value gains and losses on underlying reserves) and fair value changes in traded derivatives (my measure of fair value gains and losses on derivatives) is a negative 0.13 (p = 0.01 for a one-tailed test).

FIGURE 1
Oil and Gas Price Behavior Over the Sample Period (1993–1996)



Oil price is the spot price per barrel of the West Texas Intermediate grade of crude oil. Gas price is the spot price per million British thermal units of the Henry Hub grade of natural gas. All prices are as of the first trading day of the month.

$$
\begin{aligned}
R_{j,m} = {} & \lambda_0 + \lambda_1 MKTRET_m + \lambda_2 \Delta OPRICE\%_m + \lambda_3 \Delta GPRICE\%_m \\
& + \eta_r\,(\Delta FV_{u,oil,j,y}/MVE_y) + \eta_d(\Delta FV_{d,oil,j,y}/MVE_y) \\
& + \omega_r\,(\Delta FV_{u,gas,j,y}/MVE_y) + \omega_d\,(\Delta FV_{d,gas,j,y}/MVE_y) + \varepsilon_{j,m}. \qquad (16)
\end{aligned}
$$

Recall that coefficients η_r and ω_r are expected to be positive whereas coefficients η_d and ω_d are predicted to be negative. Further, the nonzero intercept η_0 from equation (14) and ω_0 from equation (15) would be reflected in nonzero coefficients λ_2 and λ_3 in equation (16).

I use change in the net present values of oil and gas reserves due to change on oil and gas prices reported per SFAS No. 69 (hereafter, SFAS No. 69 price revision disclosures) to measure $\Delta FV_{u,oil}$ and $\Delta FV_{u,gas}$. I measure $\Delta FV_{d,oil}$ and $\Delta FV_{d,gas}$ as fair value gains and losses on derivatives for which fair value data are available (hereafter, traded derivatives), adjusted for realized gains and losses in traded derivatives during the year. Exhibits 2 and 3 provide examples of SFAS No. 69 price revisions and fair value changes of traded derivatives for a typical sample firm, Newfield Exploration Company.

Shortcomings in the data impose several limitations on the model specification. These limitations require equation (16) to be revised as follows:

$$\begin{aligned} R_{j,m} = {} & \alpha_0 + \alpha_1 MKTRET_m + \alpha_2 \Delta OPRICE\%_m + \alpha_3 \Delta GPRICE\%_m \\ & + \alpha_4(\text{SFAS No. 69 price revisions}_{j,y}/MVE_{y-1}) \\ & + \alpha_5(\text{fair value change in traded derivatives}_{j,y}/MVE_{y-1}) \\ & + \alpha_6(\Delta OPRICE\%_m \times \text{quantity of oil reserve changes}_{j,y}/MVE_{y-1}) \\ & + \alpha_7(\Delta GPRICE\%_m \times \text{quantity of gas reserve changes}_{j,y}/MVE_{y-1}) \\ & + \alpha_8(\Delta OPRICE\%_m \times \text{notional quantity of oil OTC derivatives-short}_{j,y}/MVE_{y-1}) \\ & + \alpha_9(\Delta GPRICE\%_m \times \text{notional quantity of gas OTC derivatives-short}_{j,y}/MVE_{y-1}) \\ & + \varepsilon_{j,m}. \end{aligned} \tag{17}$$

Equation (17) is the model actually used to assess the risk-relevance of the fair value price revisions based on SFAS No. 69 disclosures and fair value change in traded derivatives. The rationale behind estimating equation (17) is guided by three specific data-related constraints.

First, SFAS No. 69 price revisions and fair value change in traded derivatives cannot be readily decomposed into fair value changes pertaining to the oil component and gas component. Therefore, coefficient α_4 in equation (17) represents the joint impact of fair value changes in both oil and gas reserves on oil and gas price sensitivity. Coefficient α_4 is predicted to be positive because η_r on $\Delta FV_{u,oil,j,y}$ and ω_r on $\Delta FV_{u,gas,j,y}$ are each predicted to be positive in equation (16). Similarly, coefficient α_5 in equation (17) represents the joint impact of fair value changes in both oil and gas traded derivatives and is expected to be negative because η_d on $\Delta FV_{d,oil,j,y}$ and ω_d on $\Delta FV_{d,gas,j,y}$ are each predicted to be negative in equation (16). In sum, I expect coefficient α_4 (α_5) to be positive (negative) if SFAS No. 69 price revisions (fair value change in traded derivatives)—proxies for sensitivity analysis disclosures—are associated with the information set that the market uses to set oil and gas price sensitivity.

Second, SFAS No. 69 price revision disclosures measure change in oil and gas prices between the last day of the current and previous fiscal year as applied to the *previous year-end's* reserve quantities (SFAS No. 69, para. 33). A complete estimate of the fair value sensitivity of underlying exposure to price changes would incorporate the contribution of the current year's net reserve additions to such sensitivity. Although data to quantify such contribution are not readily available, I include two variables in equation (17) to proxy for monthly fair value gains and losses on net reserve additions during the year: (1) the product of $\Delta OPRICE\%_m$ with the quantity of the year's net oil reserve additions and (2) the product of $\Delta GPRICE\%_m$ with the quantity of the year's net gas reserve additions. Because reserve additions increase a firm's long position in oil and gas, I expect coefficients α_5 and α_6 to be positive. It is noteworthy that the median firm adds about 11 (10) percent of its beginning of the year oil (gas) reserve stock during the sample period.

Third, O&G firms ordinarily do not report fair values of commodity derivatives that are not traded on exchanges (hereafter, OTC derivatives). Such OTC derivatives are usually long-term arrangements for time periods ranging from one to ten years and are designed either to lock in future delivery prices or to accept payments for a fixed quantity of future production. I use the product of $\Delta OPRICE\%_m$ ($\Delta GPRICE\%_m$) and the year-end notional quantity of OTC oil (gas) derivatives in equation (17) as a proxy for the monthly fair value gains and losses on OTC derivatives held by a firm. Because OTC derivatives represent short positions in oil and gas, I expect coefficients α_7 and α_8 on the proxies for fair value changes in OTC derivatives to be negative. It should be recognized that OTC derivative usage is not substantial in my sample. The median firm holds no OTC derivatives. The mean sample firm hedges about 0.68 percent (2.47 percent) of its oil (gas) reserve value through OTC derivatives. In contrast, the mean sample firm hedges about 3.86 percent (7.81 percent) of its oil (gas) reserve values using both traded and OTC derivatives.

To summarize, coefficient α_4 (α_5) is expected to be positive (negative) if proxies for sensitivity analysis measures, namely SFAS No. 69 price revisions (fair value change in traded derivatives), are relevant to the market in assessing firms' oil and gas price sensitivity. Drawing from the discussion following equation (16), I expect coefficient α_2 on Δ-OPRICE$\%_m$ and α_3 on ΔGPRICE$\%_m$ to be nonzero. It is important to recognize that the predictions related to proxies for fair value changes in reserve additions and OTC derivatives are not the primary focus of the empirical test. These proxies are included in equation (17) to circumvent the interpretation that the observed effect of the test variables—SFAS No. 69 price revisions and fair value changes of traded derivatives—on oil and gas price sensitivity are due to the influence of fair value changes in reserve additions and OTC derivatives.

IV. SAMPLE SELECTION AND DATA

Sample

The sample period begins in 1993 because commodity derivative data are not readily available in annual reports before 1993. A sample of 246 O&G firms was initially compiled from the 1996 Compustat list of companies in SIC code 1311 (oil and gas production). Forty-one firms registered outside the United States were eliminated because the effect of differences in the economic financial reporting and stock market characteristics between foreign firms and U.S. corporations would be difficult to control in an empirical model. Eighty-one of the remaining firms do not have CRSP data available for any year during the period 1993 to 1996. Nine firms were eliminated because annual reports were not received and financial statements for these firms were not available from Lexis/Nexis or the SEC's EDGAR databases. Ten firms without December year-ends were also removed from the sample to facilitate matching the firm's equity returns with changes in oil and gas prices. Fifty-three firms that did not report using derivatives during the sample period were eliminated from the analysis because it is hard to assess whether these firms do not use oil and gas derivatives or do not disclose use of oil and gas derivatives. The final estimation of equation (11) includes 52 firms, or 149 firm-years, with available tabular format data. Data to assess sensitivity analysis disclosures, in particular the fair value gains and losses on derivatives, are available for 38 firms, or 89 firm-years, to estimate equation (17).

Descriptive Statistics: $B_{oil,j}$ and $B_{gas,j}$

Table 1 presents estimates of $\beta_{oil,j}$ and $\beta_{gas,j}$ from the three-factor model in equation (10) to describe the statistical characteristics of the oil and gas betas. To compute estimates of $\beta_{oil,j}$ and $\beta_{gas,j}$ I use monthly measures of MKTRET, ΔOPRICE% and ΔGPRICE% for each firm in my sample of 52 O&G firms over the sample period 1993 to 1996. Stock returns for each firm j ($R_{j,m}$) and the holding period return on the S&P 500 index (MKTRET) are obtained from CRSP. Spot price data for "West Texas Intermediate" grade of crude oil and the "Henry Hub" grade of natural gas to measure ΔOPRICE% and Δ-GPRICE% are obtained from the Bloomberg Financial Markets database.

On average, a 1 percent increase in oil prices (gas prices) leads to approximately a 0.30 percent (0.06 percent) increase in the stock return of the median firm. As expected, most of the firms in the sample (79.86 percent for oil and 68.67 percent for gas) have

TABLE 1
Descriptive Statistics for O&G Oil and Gas Betas

The table summarizes the mean, median, standard deviation, minimum and maximum of the coefficient estimates and adjusted R^2 from three-factor market model regressions in equation (10) for 52 O&G firms with complete monthly market data for the calendar years 1993–1996. Although equation (10) is not used to test the risk-relevance of disclosures, results of estimating (10) are presented to describe the statistical properties of oil and gas betas. Unlike the theory developed in sections II and III, oil and gas betas in the table are assumed to be stationary over the entire sample period. The oil price factor is the percentage change in the prices of a benchmark crude oil known as "West Texas Intermediate." The gas price factor is the percentage change in the prices of a benchmark natural gas known as "Henry Hub." The market return factor is the monthly holding period return for the Standard and Poor's (S&P) 500 portfolio.

Summary of equation (10) by firm: $R_{j,m} = \alpha_j + \beta_{mkt,j}\, MKTRET_m + \beta_{oil,j}\, \Delta OPRICE\%_m + \beta_{gas,j} \Delta GPRICE\%_m + \nu_{j,m}$

	β_{mkt}	β_{oil}	β_{gas}	*Adj. R^2*
Mean	0.809	0.247	0.072	12.52%
Median	0.915	0.300	0.061	11.36%
Standard Deviation	0.709	0.337	0.112	9.04%
Minimum	−0.791	−0.682	−0.194	0.00%
Maximum	2.741	1.124	0.314	39.46%
% > 0	90.60%	79.86%	68.67%	
% > 0 and significant at $p < 0.05$	46.58%	38.42%	36.78%	
% < 0 and significant at $p < 0.05$	0.00%	1.92%	0.00%	

Statistical significance is assessed for a one-sided hypothesis.

$R_{j,m}$ = Holding period return for firm j over month m;
$MKTRET_m$ = Holding period return for S&P 500 portfolio over month m;
$\Delta OPRICE\%_m$ = Percentage change in prices of "West Texas Intermediate" crude oil over month m;
$\Delta GPRICE\%_m$ = Percentage change in prices of "Henry Hub" natural gas over month m.

positive oil and gas betas, consistent with the fact that most sample firms hold net long positions in oil and gas. Of the 52 firms in the sample, 38.42 percent (36.78 percent) have positive and statistically significant oil (gas) betas at the 5 percent level of significance for a one-tailed test. In comparison, 46.58 percent of the market betas are positive and statistically significant (at the 5 percent level for a one-tailed test).

It is important to remember that the oil and gas betas reported in table 1 contain measurement error because they are averages over the 1993–1996 period, whereas the theory underlying the empirical specifications in equations (11) and (17) suggests that oil and gas price sensitivities depend on firm-specific and time-period-specific stock of underlying reserves and the derivative strategy. The tests of equations (11) and (17) that follow in section V assume that the measures of firm-specific and period-specific sensitivities have enough systematic information content that they are not completely dominated by measurement error. The presence of significant firm-specific sensitivities displayed in table 1 provides some evidence that the assumption is reasonable within the sample. In particular, the number of significant oil and gas sensitivities are quite large when viewed from the perspective of the number of market betas that are significantly positive. However, a failure to document a relation between the examined disclosures and oil and gas price sensitivities could be the result of measurement error in the O&G price sensitivities rather than the irrelevance of the disclosures.

Independent Variables: Descriptive Statistics and Analyses

Panel A of table 2 provides descriptive data on the characteristics of underlying exposure, measured as value of proven reserves and derivative commodity instruments, measured as notional values of short positions in oil and gas for the entire sample of 149 firm-years. The mean (median) firm hedges 3.86 percent (1.29 percent) of its oil reserves and 7.81 percent (4.09 percent) of its gas reserves. The percentage of reserves hedged shows significant cross-sectional variation with a standard deviation of 6.71 percent for oil and 10.19 percent for gas. The maximum percentage of reserves hedged is 52 percent for oil and 54.9 percent for gas. Thus, no firm hedges more than 100 percent of its reserves, implying that firms have a net long position in oil and gas price risk. This finding is consistent with the earlier evidence that 38.42 percent (36.78 percent) of firms have significantly positive oil (gas) betas while only 1.2 percent (0 percent) of the firms have significantly negative oil (gas) betas. The relatively small percentages of hedging activity observed in panel A of table 3 suggest firms possibly hedge near-term, say next year's production. However, 63 percent of the firm-years in the sample held derivatives whose duration exceeded one year (results not tabulated). Hence, a majority of the firms appear to hedge future production scheduled beyond one year, providing some support for measuring underlying exposure in terms of proven reserves rather than next year's production.[13]

Panel B of table 2 presents statistics on the type of derivative instrument that firms use to assume short positions in oil and gas. Forward contracts are the most common derivative instrument used to assume short positions in oil and gas; 50 (69) firm years have oil (gas) forwards outstanding with median oil (gas) hedge ratios of 5.86 percent (4.97 percent). The use of options is relatively uncommon with 3 (8) firm-years reporting median oil (gas) hedge ratio of negative 0.08 percent (0.98 percent).[14] This is important because the association between the oil or gas beta and the notional value of commodity derivatives would be biased toward zero if options were the most commonly used instrument to assume short positions in oil and gas.

Panel C of table 2 presents descriptive statistics of SFAS No. 69 price revisions and traded derivative fair value gains and losses, expressed as a percentage of lagged market value, for a subsample of 89 firm-years where fair value gains and losses of traded derivatives were reported in the financial statements. The mean (median) firm reported a fair value gain in reserves equal to 26.89 percent (11.87 percent) of its lagged market value. A small portion of such fair value *gain* in underlying exposure of the mean (median) firm was offset with a 0.23 percent (0.06 percent) fair value *loss* in traded derivatives.

---

[13] Even if we assume for the sake of argument that firms hedged only next-year's production, the fair values of proven reserves to be produced in the future are still exposed to current oil and gas price fluctuations. In fact, Clinch and Magliolo (1992) demonstrate that oil production as far down as three years from now is positively associated with current year's oil price sensitivities. Such association provides another motivation to measure underlying exposure in terms of proven reserves.

[14] An option that represents the sale of future production at some floor price was coded as a short position. Collars representing a short oil or gas position at some floor price and a long oil or gas position at some ceiling price were coded separately as a short and a long position. The median hedge ratio of −0.08 percent corresponding to oil options represents the net long leg of an oil collar.

TABLE 2
Descriptive Statistics of Independent Variables

Panel A: Underlying Exposure and Commodity Derivatives

Variable	1st Quartile	Median	3rd Quartile	Mean	Std. Dev.	Min.	Max.
Value of proven oil reserves/MVE_{y-1}	0.90	1.88	4.25	3.19	3.66	0.03	31.07
Notional value of oil-short/MVE_{y-1}	0.00	0.02	0.12	0.13	0.34	0	3.43
Value of proven gas reserves/MVE_{y-1}	1.41	2.11	3.31	3.40	4.28	0.37	53.05
Notional value of gas-short/MVE_{y-1}	0.02	0.08	0.26	0.36	0.98	0	9.74
Notional value of oil-short/Value of proven oil reserves (%)	0.50	1.29	5.66	3.86	6.71	0	52.35
Notional value of gas-short/Value of proven gas reserves (%)	1.17	4.09	10.43	7.81	10.19	0	54.92
Value of proven gas reserves/Value of total proven reserves (%)	39.79	56.19	70.14	54.30	22.47	8.2E–4	97.58
MVE (in $ million)	62.65	172.34	691.02	580.26	966.51	5.31	5495.00

Statistics are reported for the sample of 149 firm-year observations used to evaluate the tabular disclosures. Value of proven oil (gas) reserves is measured as the quantity of proven oil (gas) reserves at year-end reported per SFAS No. 69 multiplied by the year-end spot oil (gas) price. Notional value of oil (gas)-short refers to the quantity of oil (gas) hedged times the weighted average price at which the oil (gas) is sold forward. MVE_{y-1} refers to market value of equity at the beginning of the year y.

Panel B: Firm years reporting notional value of oil (gas) derivatives-short outstanding at year end as a percentage of the value of oil (gas) reserves classified by instrument. Only nonzero observations, indicated as n ≠ 0, are included.

Derivative	N ≠ 0	1st Quartile	Mean	Median	3rd Quartile	Min.	Max.
Oil futures	6	1.18	3.72	2.07	4.61	0.38	10.37
Gas futures	17	0.36	4.69	0.81	8.86	0.11	14.13
Oil forwards	50	2.41	7.73	5.86	10.26	0.67	47.03
Gas forwards	69	2.75	8.20	4.97	10.49	0.05	33.59
Oil swaps	14	1.47	3.74	3.46	3.93	0.12	10.61
Gas swaps	48	1.32	6.91	4.03	7.63	0.10	41.10
Oil options	3	−2.95	−1.54	−0.08	0.61	−5.83	1.30
Gas options	8	0.52	1.10	0.98	1.51	0.08	2.53

(Continued on next page)

TABLE 2 (Continued)

Panel C. Fair value gains and losses on reserves and traded derivatives (% of lagged market value of equity).

Variable	*1st Quartile*	*Median*	*3rd Quartile*	*Mean*	*Std. Dev.*	*Min.*	*Max.*
SFAS No. 69 price revisions (%)	−11.69	11.87	47.10	26.89	74.37	−75.42	275.67
Fair value change in traded derivatives (%)	−1.90	−0.06	1.28	−0.23	10.91	−11.08	8.39

Statistics are reported for the sample of 89 firm-year observations used to evaluate the sensitivity analysis disclosures. These 89 firm-year observations disclose fair value change in traded derivatives (derivatives whose fair values are reported in financial statements) during the years 1993–1996. SFAS No. 69 price revisions refer to oil and gas price-induced change in SFAS No. 69 reserve present values for a year. Fair value change in traded derivatives refers to the difference in fair values of traded oil and gas derivatives between the last and first day of a year adjusted for realized gains and losses in traded derivatives during the year.

V. RESULTS

Tabular Format

Column A of table 3 presents the results from estimating equation (11) using pooled observations across all periods. The coefficients on $\Delta OPRICE\%_m$ and $\Delta GPRICE\%_m$ indicate that for every percentage point change in oil and gas prices during a month, the monthly returns of sample firms change by 0.29 percent and 0.05 percent, respectively. The significant coefficients on $\Delta OPRICE\%_m$ and $\Delta GPRICE\%_m$ suggest a strong firm-specific and time-invariant relation between changes in oil and gas prices and firm-specific returns, even after controlling for variation in underlying reserves and derivative positions on oil and gas price sensitivities. Such coefficients may reflect, among other things, the omitted effects of cross-sectional and inter-temporal differences in tax rates and competitive exposures. Column A of table 3 also indicates that the notional value of oil derivatives-short (coefficient = −0.455; p-value = 0.00) and the notional value of gas derivatives-short (coefficient = −0.061; p-value = 0.02) exhibit strong negative associations with oil and gas price sensitivities, as expected. However, the associations between proven reserve values and oil and gas betas are not as strong. While the value of proven gas reserves exhibits a significant positive association with gas betas (coefficient = 0.010; p-value = 0.07), the value of proven oil reserves (coefficient = 0.021; p-value = 0.13) is not significantly different from zero. Two factors may explain the weak associations between reserve information and oil and gas betas. First, the reserve value variable is employed in the context of one simple, easily implemented, cross-sectional model in equation (11). Users might employ other or more sophisticated models in evaluating reserve quantity disclosures. To the extent that this is the case, predictions from the model in equation (11) do not necessarily hold. Second, because proven reserves are subjective geological estimates determined by firms' managers, unreliability and bias in proven reserve estimates may render the coefficients on the reserve values insignificant.

I employ a procedure used by Clinch and Magliolo (1992) to assess whether unreliability and bias in reserve estimates possibly swamp the significance of reserve quantity

TABLE 3
Estimation of Oil and Gas Price Sensitivity and Its Association with Tabular Format Measures of Net Commodity Price Risk Exposure

Equation (11): $R_{j,m} = \gamma_0 + \gamma_1 MKTRET_m + \gamma_2 \Delta OPRICE\%_m + \gamma_3 \Delta GPRICE\%_m + \gamma_4 \Delta OPRICE\%_m$
$\times$ *value of proven oil reserves*$_{j,y}$/$MVE_{j,y-1}$ + $\gamma_5 \Delta OPRICE\%_m$
$\times$ *notional value of oil derivatives-short*$_{j,y}$/$MVE_{j,y-1}$ + $\gamma_6 \Delta GPRICE\%_m$
$\times$ *value of proven gas reserves*$_{j,y}$/$MVE_{j,y-1}$ + $\gamma_7 \Delta GPRICE\%_m$
$\times$ *notional value amount of gas derivatives-short*$_{j,y}$/$MVE_{j,y-1}$ + $\varepsilon_{j,m}$

		Underlying Exposure and Derivatives Column A		*Reliability and Bias Corrections Column B*	
Independent Variables	*Pred. Sign*	*Coeff.*	*p-value*	*Coeff.*	*p-value*
Intercept	?	−0.001	0.77	−0.000	0.80
MKTRET%	+	0.762***	0.00	0.748***	0.00
ΔOPRICE%	+	0.297***	0.00	0.261***	0.00
ΔGPRICE%	+	0.051**	0.01	0.055**	0.01
ΔOPRICE% × value of proven oil reserves	+	0.021	0.13	0.051**	0.04
ΔOPRICE% × notional value of oil derivatives-short	−	−0.455***	0.00	−0.541***	0.00
ΔGPRICE% × value of proven gas reserves	+	0.010*	0.07	0.012*	0.06
ΔGPRICE% × notional value of gas derivatives-short	−	−0.061**	0.02	−0.032**	0.05
Reliability and bias corrections					
ΔOPRICE% × value of proven oil reserves × absolute revisions dummy	−			0.011	0.59
ΔGPRICE% × value of proven gas reserves × absolute revisions dummy	−			−0.001	0.88
ΔOPRICE% × value of proven oil reserves × signed revisions dummy	−			−0.038**	0.04
ΔGPRICE% × value of proven gas reserves × signed revisions dummy	−			−0.004**	0.04
R^2		10.22%		11.31%	
F-value		29.13		18.04	

(*Continued on next page*)

TABLE 3 (Continued)

Data includes 149 firm-year observations over calendar years 1993 to 1996. The number of observations used in the regression is 1788. The t-statistics used to report p-values are calculated using White's (1980) robust standard errors.

*,**,*** indicate that coefficients are statistically different from zero at 0.10, 0.05, 0.001 level, respectively.

Statistical significance is assessed for a one- (two-) tailed test when the hypothesized sign of the coefficient is predicted (not predicted). Absolute revisions dummy assumes a value of 1 (0) when the ratio of absolute reserve revisions divided by beginning proven reserve quantity for a firm over the period 1991–1996 is above (below) the median ratio for all firms in the sample. Signed revisions dummy assumes a value of 1 (0) when the ratio of signed reserve revisions divided by beginning proven reserve quantity for a firm over the period 1991–1996 is above (below) the median ratio for all firms in the sample. For other variable definitions, see tables 1 and 2.

estimates. In particular, I explore differential informativeness of reserve information by adding two interaction terms to the model. The interaction terms are the product of the reserve values in table 3 and two dummy variables. To obtain the dummy variables, I compute the variables described below using all available data for each firm in the years 1991–1996. If the variable value was above (below) the median value for the sample, the dummy was assigned a value of 1 (zero). The two dummy variables are based on average absolute revisions and average revisions, respectively.[15] To calculate average absolute revisions, I divide the absolute value of reported oil or gas revisions by the beginning proven oil or gas reserve estimate, respectively. Following Clinch and Magliolo (1992), I interpret the average absolute revisions variable as a proxy for uncertainty attached to the firm's reserve estimates. Because I expect investors to place less reliance on reserves they perceive to contain more error, I predict a negative association between this interaction variable and oil and gas betas.

The second dummy variable is calculated in the same way as the absolute revisions variable except that the signed revision disclosures are used, thereby accounting for the direction of revisions. If some firms systematically under- or overestimate disclosed reserves by reporting negative or positive revisions, investors would be expected to adjust the reported reserve estimates upward or downward. Hence, I expect a negative relation between this interaction variable and oil and gas betas.

Results of estimating the model after adding dummy variables for uncertainty and bias in reserves are reported in column B of table 3. Coefficients on value of oil reserves (0.051; p-value = 0.04) and the value of gas reserves (0.012; p-value = 0.06) are now statistically significant, as expected. The absolute revisions interaction term for both oil and gas is not statistically significant. However, the average revisions interaction is significantly negative, as expected, for both oil revisions (−0.038, p-value = 0.04) and gas revisions (−0.004, p-value = 0.04). This suggests that any systematic optimism or conservatism in reserve estimates is appropriately adjusted by the market. Moreover, the coefficient on the interaction of ΔOPRICE% and the value of oil reserves adjusted for systematic bias is 0.013 (0.051 − 0.038) and is statistically significant at p-value = 0.03 for a one-tailed test. Similarly, the coefficient on the interaction of ΔGPRICE% and the value of gas reserves adjusted for systematic bias is 0.008 (0.012 − 0.004) and is statistically significant at p-value = 0.07 for a one-tailed test. Hence, the value of oil and gas reserves is significantly

[15] The findings are qualitatively similar when continuous counterparts are used instead of dummy variables. However, t-statistics on the interaction variables are somewhat reduced when using continuous ratios, possibly because of estimation error in the ability of the continuous ratio to capture uncertainty and bias in reserve estimates.

associated with the oil and gas betas for the subset of firms whose reserve disclosures are perceived by the market to contain less measurement error than that of the median firm.

The notional value of oil and gas derivatives-short exhibits robust negative associations with oil and gas betas in all the model specifications discussed above. In sum, I find evidence that my proxy for tabular disclosures with respect to derivatives—the notional value of oil- or gas-short—is significantly associated with a market-based measure of oil and gas exposure, the oil and gas betas. However, my proxy for tabular disclosures with respect to underlying reserves is risk-relevant only when the market perceives such reserves estimates to contain less error than average.

Sensitivity Analysis Format

The results of estimating equation (18) are reported in table 4. The coefficients on $\Delta OPRICE\%_m$ (0.273, p-value = 0.00) and $\Delta GPRICE\%_m$ (0.076, p-value = 0.00) are similar in magnitude to those reported in table 4. As before, significant $\Delta OPRICE\%_m$ and $\Delta GPRICE\%_m$ coefficients suggest a strong firm-specific and time-invariant relation between changes in oil and gas prices and firm-specific returns, even after accounting for the impact of cross-sectional variation in fair value changes in underlying reserves and derivative positions on oil and gas price sensitivities. Factors such as tax rates and competitive exposures, among other things, are likely to be embedded in firms' oil and gas price sensitivities but missing from the fair value change measures considered here. As expected, the coefficient on SFAS No. 69 price revisions scaled by lagged market value is positive and significant (0.117; p-value = 0.00) while the coefficient on fair value gains and losses on traded derivatives is negative and significant (−0.085; p-value = 0.00). Thus, fair value sensitivity of reserves and commodity derivatives are strongly associated with market-based measures of oil and gas betas.

As noted in section III, SFAS No. 69 price revisions ignore the fair value gains and losses on reserve additions while fair value changes in traded derivatives do not include fair value gains and losses on OTC derivatives. Column B of table 4 shows that the significant associations reported in column A are unaffected by including proxies for these omitted variables. In general, proxies for omitted fair value effects are not statistically significant. However, the coefficient on fair value changes in gas reserve additions is positive and significant, as expected.

Thus, I find robust evidence that my fair value measures that proxy for sensitivity analysis disclosures are associated with oil and gas betas in the predicted direction. These results are inconsistent with claims made by AICPA (1998) and some commentators (see section VI (4) of SEC [1997]) that sensitivity analysis measures are too dependent on assumptions to be reflective of firms' market risk exposures.

The Incremental Information Content of the Proxies for Tabular and Sensitivity Analysis Format

The information in the tabular format disclosures is likely to be different from sensitivity analysis disclosures because users are expected to approximate a firm's market risk exposure from tabular format information while firms explicitly report estimates of their market risk exposure under the sensitivity analysis format. Because my sample includes proxies for tabular and sensitivity analysis disclosures *for the same set of firms*, I provide evidence to examine concerns, expressed notably by the U.S. Senate Subcommittee on Securities (1997), that the presence of more than one reporting option under SEC (1997) may harm investors' ability to compare one firm's risk exposures with the risk exposures of another firm. Official SEC disclosures, even when they become available, cannot be used

TABLE 4

Estimation of Oil and Gas Price Sensitivity and Its Association with Sensitivity Analysis Format Measures of Net Commodity Price Risk Exposure

Equation (17): $R_{j,m} = \alpha_0 + \alpha_1\, MKTRET_m + \alpha_2\, \Delta OPRICE\%_m + \alpha_3\, \Delta GPRICE\%_m$
$+ \alpha_4\, (SFAS\ No.\ 69\ price\ revisions_{j,y}/MVE_{y-1})$
$+ \alpha_5\, (fair\ value\ change\ in\ traded\ derivatives_{j,y}/MVE_{y-1})$
$+ \alpha_6\, (\Delta OPRICE\%_m \times quantity\ of\ oil\ reserve\ changes_{j,y}/MVE_{y-1})$
$+ \alpha_7\, (\Delta GPRICE\%_m \times quantity\ of\ gas\ reserve\ changes_{j,y}/MVE_{y-1})$
$+ \alpha_8\, (\Delta OPRICE\%_m \times notional\ quantity\ of\ oil\ OTC\ derivatives\text{-}short_{j,y}/MVE_{y-1})$
$+ \alpha_9\, (\Delta GPRICE\%_m \times notional\ quantity\ of\ gas\ OTC\ derivatives\text{-}short_{j,y}/MVE_{y-1})$
$+ \varepsilon_{j,m}$

Independent Variables	Pred. Sign	*Underlying Exposure and Derivatives* Column A Coeff.	p-value	*Underlying Exposure, Derivatives and Proxies for Omitted Variables* Column B Coeff.	p-value
Intercept	?	−0.004	0.32	−0.004	0.36
MKTRET	+	0.723***	0.00	0.713***	0.00
ΔOPRICE%	+	0.273***	0.00	0.303***	0.00
ΔGPRICE%	+	0.076***	0.00	0.011***	0.00
SFAS No. 69 price revisions	+	0.117***	0.00	0.011***	0.00
Fair value change in traded derivatives	−	−0.085***	0.00	−0.083***	0.01
Reserve changes and OTC derivative proxies					
ΔOPRICE% × quantity of oil reserve changes	+			−0.075	0.19
ΔGPRICE% × quantity of gas reserve changes	+			0.032**	0.05
ΔOPRICE% × notional quantity of oil OTC derivatives-short.	−			0.017	0.78
ΔGPRICE% × notional quantity of OTC gas derivatives-short	−			0.014	0.38
R^2		12.99%		13.22%	
F-value		27.48		21.08	

Data includes 89 firm-year observations over calendar years 1993 to 1996. The number of observations used in the regressions is 1068. The t-statistics used to report p-values are calculated using White's (1980) robust standard errors.

*,**,*** indicate that coefficients are statistically different from zero at 0.10, 0.05, 0.001 level, respectively. Statistical significance is assessed for a one- (two-) tailed test when the hypothesized sign of the coefficient is predicted (not predicted). For variable definitions, see tables 1 and 2.

for such an analysis because a firm is not required to report market risk disclosures under more than one format.

If the tabular and sensitivity analysis disclosures capture different attributes of a firm's net market risk exposure, I expect my proxies from one format to exhibit incremental association over proxies from another format in explaining the firm's oil and gas betas. I assess such incremental association by combining the empirical models in equations (11) and (17):

$$\begin{aligned} R_{j,m} = {} & \theta_0 + \theta_1 MKTRET_m + \theta_2 \Delta OPRICE\%_m + \theta_3 \Delta GPRICE\%_m \\ & + \theta_4(\Delta OPRICE\%_m \times \text{value of proven oil reserves}_{j,y}/MVE_{y-1}) \\ & + \theta_5(\Delta OPRICE\%_m \times \text{notional value of oil derivatives-short}_{j,y}/MVE_{y-1}) \\ & + \theta_6(\Delta GPRICE\%_m \times \text{value of proven gas reserves}_{j,y}/MVE_{y-1}) \\ & + \theta_7(\Delta GPRICE\%_m \times \text{notional value of gas derivatives-short}_{j,y}/MVE_{y-1}) \\ & + \theta_8(\text{SFAS No. 69 price revisions}_{j,y}/MVE_{y-1}) \\ & + \theta_9(\text{fair value change in traded oil and gas derivatives}_{j,y}/MVE_{y-1}) + \varepsilon_{j,m}. \end{aligned} \quad (18)$$

Statistically significant θ_4, θ_5, θ_6, θ_7, θ_8 and θ_9 would suggest that the proxies for tabular format disclosures and the proxies of the sensitivity analysis disclosures are not substitutes for each other in explaining firms' oil and gas betas. As before, θ_4, θ_6 and θ_8 are expected to be positive, but θ_5, θ_7 and θ_9 are expected to be negative.

Table 5 reports that proxies for the tabular format and sensitivity disclosures *for the same set of firms* consistently exhibit incremental information over each other. For example, the notional value of oil and gas derivatives-short, representing the tabular format measure for derivatives, and SFAS No. 69 price revisions and fair value of traded derivatives, representing the sensitivity analysis measures, are significantly associated with oil and gas betas in the predicted direction (see column A). When the interaction variables for reliability and bias in reserve estimates are added to the specification (see column B), the coefficient on value of proven oil reserves adjusted for bias is 0.004 (0.049 − 0.045) and significant ($p = 0.03$). These findings are robust to addition of proxies to control for the incompleteness of SFAS No. 69 price revisions and fair value changes in traded derivatives.[16] Hence, the results provide evidence that the two forms of quantitative disclosure, namely the tabular and sensitivity analysis formats, are not entirely substitutable. Allowing firms to choose different formats for reporting their market risk exposure is likely to limit the inter-firm comparability of such disclosures.

VI. CONCLUSIONS

I examine the association between oil and gas price sensitivity and proxies for commodity risk exposure measures for a sample of oil and gas producers. The measures of derivatives and underlying exposure from reserves, derived from existing SFAS No. 119 and SFAS No. 69 disclosures, are analogous to tabular format and sensitivity analysis disclosures prescribed by SEC (1997) for all firms for fiscal periods ending after June 15,

[16] The tenor of the results was unchanged when the interaction between $\Delta OPRICE\%_m$ and $\Delta GPRICE\%_m$ with three alternate accounting proxies for risk, namely size (market capitalization), leverage (debt-to-size) and market-to-book ratios, were added to the empirical specifications in equations (11), (17) and (18).

TABLE 5
Estimation of Oil and Gas Price Sensitivity and the Incremental Association of Tabular and Sensitivity Analysis Format Measures of Net Commodity Price Risk Exposure

Equation (18): $R_{j,m} = \theta_0 + \theta_1 MKTRET_m + \theta_2 \Delta OPRICE\%_m + \theta_3 \Delta GPRICE\%_m$
$+ \theta_4(\Delta OPRICE\%_m \times value\ of\ proven\ oil\ reserves_{j,y}/MVE_{j,y-1})$
$+ \theta_5(\Delta OPRICE\%_m \times notional\ value\ of\ oil\ derivatives\text{-}short_{j,y}/MVE_{j,y-1})$
$+ \theta_6(\Delta GPRICE\%_m \times value\ of\ proven\ gas\ reserves_{j,y}/MVE_{j,y-1})$
$+ \theta_7(\Delta GPRICE\%_m \times notional\ value\ of\ gas\ derivatives\text{-}short_{j,y}/MVE_{j,y-1})$
$+ \theta_8(SFAS\ No.\ 69\ price\ revisions_{j,y}/MVE_{y-1})$
$+ \theta_9(fair\ value\ change\ in\ traded\ oil\ and\ gas\ derivatives_{j,y}/MVE_{y-1})$
$+ \varepsilon_{j,m}$

Independent Variables	Pred. Sign	*Tabular and Sensitivity Analysis Format Column A* Coeff.	*Column A* p-value	*Tabular and Sensitivity Analysis Format with Omitted Variables and Reliability and Bias Corrections Column B* Coeff.	*Column B* p-value
Intercept	?	−0.004	0.27	−0.004	0.29
MKTRET	+	0.713***	0.00	0.709***	0.00
ΔOPRICE%	+	0.326***	0.00	0.298***	0.00
ΔGPRICE%	+	0.076***	0.00	0.075***	0.00
Tabular variables					
ΔOPRICE% × value of proven oil reserves	+	0.007	0.36	0.049**	0.05
ΔOPRICE% × notional value of oil derivatives-short	−	−0.573***	0.00	−0.595***	0.00
ΔGPRICE% × value of proven gas reserves	+	0.003	0.17	0.004	0.30
ΔGPRICE% × notional value of gas derivatives-short	−	−0.028*	0.10	−0.012*	0.09
Sensitivity analysis variables					
SFAS No. 69 price revisions	+	0.012**	0.00	0.011**	0.00
Fair value change in traded oil and gas derivatives	−	−0.069**	0.03	−0.061**	0.03

(*Continued on next page*)

TABLE 5 (Continued)

Independent Variables	*Pred. Sign*	*Tabular and Sensitivity Analysis Format Column A* *Coeff.*	*p-value*	*Tabular and Sensitivity Analysis Format with Omitted Variables and Reliability and Bias Corrections Column B* *Coeff.*	*p-value*
Reliability and bias corrections in tabular disclosures					
ΔOPRICE% × value of proven oil reserves × absolute revisions dummy	−			−0.006	0.40
ΔGPRICE% × value of proven gas reserves × absolute revisions dummy	−			0.002	0.38
ΔOPRICE% × value of proven oil reserves × signed revisions dummy	−			−0.045**	0.03
ΔGPRICE% × value of proven gas reserves × signed revisions dummy	−			−0.008**	0.05
Reserve change and OTC derivative proxies from sensitivity analysis disclosures					
ΔOPRICE% × quantity of oil reserve changes	+			−0.086	0.33
ΔGPRICE% × quantity of gas reserve changes	+			−0.003*	0.07
ΔOPRICE% × notional quantity of oil OTC derivatives-short	−			0.013	0.67
ΔGPRICE% × notional quantity of gas OTC derivatives-short	−			0.001	0.47
R^2		13.70%		14.06%	
F-value		18.34		13.51	

Data includes 89 firm-year observations over calendar years 1993 to 1996. The number of observations used in the regressions is 1068. The t-statistics used to report p-values are calculated using White's (1980) robust standard errors.

*,** indicate that coefficients are statistically different from zero at 0.10, 0.05 level, respectively, two-tailed test. Statistical significance is assessed for a one- (two-) tailed test when the hypothesized sign of the coefficient is predicted (not predicted). For variable definitions, see tables 1, 2, 3 and 4.

1998. The availability of SFAS No. 69 and SFAS No. 119 data provides the opportunity to test the risk-relevance of proposed risk disclosures now, rather than waiting until actual SEC (1997) data becomes widely available under alternative disclosure formats.

The results indicate that tabular format disclosures on derivatives and sensitivity analysis format disclosures of underlying exposure and derivatives are associated with firms' oil and gas price sensitivity. Disclosures of underlying exposure from firm's reserves under the tabular format are statistically associated with the firms' oil and gas price sensitivity for that subset of firms whose disclosures the market perceives to contain less measurement error than those of the median firm. The sensitivity analysis disclosures are associated with oil and gas price sensitivities. Thus, both formats suggested by the SEC provide information associated with firms' exposures to commodity price risk. Moreover, the alternate formats are not replacements for one another. They each have incremental information content in explaining firms' oil and gas price sensitivities.

Several factors limit the ability to generalize the findings to a broader population of firms. First, my sample includes firms that *voluntarily* disclose commodity derivative information. Thus, because of the possibility of self-selection bias, there is no assurance that the results from my sample would generalize to a broader population of firms that are required to disclose their derivative activities. Second, the present analysis is limited to firms in one industry. Although focusing on O&G firms enables me to make precise predictions about the sign of coefficients on proxies for SEC disclosures, results from the study may not readily generalize to other industries, especially when measures of underlying risk exposure are not readily available. Third, estimated fair value sensitivity measures, explained in section III, cannot be fully validated because only three firm-years in my sample explicitly report fair value sensitivity measures.

Subject to the above caveats, the paper provides early evidence suggesting that tabular and sensitivity analysis disclosures are risk-relevant and that the two formats reflect different attributes of commodity price risk. The fact that the formats reflect different risk attributes is likely to mean that investors will have difficulty in comparing the results of the risk management activities of firms that choose different disclosure formats. Just how the above caveats impact these results can be determined by studies that employ either alternate research methodologies such as laboratory markets (see Dietrich et al. 1998) or that examine the actual SEC (1997) disclosures, once the disclosures are widely available.

REFERENCES

Alciatore, M. 1990. The reliability and relevance of reserve value accounting data: A review of the empirical research. *Journal of Accounting Literature* 9: 1–38.

American Institute of Certified Public Accountants (AICPA). 1998. *Interpretation of AU Section 634, Letters for Underwriters and Certain Other Requesting Parties, Commenting in a Comfort Letter on Quantitative Disclosures About Market Risk Made in Accordance with Item 305 of Regulation S-K.* New York, NY: AICPA.

Clinch, G., and J. Magliolo. 1992. Market perceptions of reserve disclosures under SFAS No. 69. *The Accounting Review* 67 (October): 843–861.

Collins, D. W., and M. Venkatachalam. 1997. Derivatives disclosures and interest exposure of commercial banks. Working paper, University of Iowa, Iowa City, IA.

Dietrich, J. R., S. J. Kachelmeier, D. N. Klienmuntz, and T. J. Linsmeier. 1998. An experimental investigation of forward-looking non-financial performance disclosures. Working paper, University of Illinois at Urbana–Champaign and University of Texas at Austin.

Financial Accounting Standards Board (FASB). 1982. *Disclosure about Oil and Gas Producing Activities.* Statement of Financial Accounting Standards No. 69. Stamford, CT: FASB.

———. 1994. *Disclosure about Derivative Financial Instruments and Fair Value of Financial Instruments.* Statement of Financial Accounting Standards No. 119. Stamford, CT: FASB.

Lehn, K. 1997. Testimony concerning disclosure of accounting policies for derivatives and disclosures of quantitative and qualitative information about market risk inherent in market risk sensitive instruments before the Subcommittee on Securities Committee on Banking, Housing, and Urban affairs. 105th Congress, 1st session, March 4.

Linsmeier, T. J., and N. D. Pearson. 1997. Quantitative disclosures of market risk in the SEC release. *Accounting Horizons* 11 (March): 107–135.

Logan, D. T., and P. M. Montgomery. 1997. Testimony on behalf of the Treasury Management Association concerning disclosure of accounting policies for derivatives and disclosures of quantitative and qualitative information about market risk inherent in market risk sensitive instruments before the Subcommittee on Securities Committee on Banking, Housing, and Urban affairs. 105th Congress, 1st session, March 4.

Magliolo, J. 1986. Capital market analysis of reserve recognition accounting. *Journal of Accounting Research* 24 (Supplement): 69–108.

Miller, M., and C. Upton. 1985a. A test of the Hotelling valuation principle. *Journal of Political Economy* 93 (February): 1–25.

———, and ———. 1985b. The pricing of oil and gas firms: Some further results. *Journal of Finance* 40 (July): 1009–1018.

Nabar, S. 1995. The usefulness of hedging disclosures: Evidence from the precious metal mining industry. Working paper, University of Texas at Austin.

Pillof, S. J. 1994. The impact of derivatives on bank risk and value. Working paper, University of Pennsylvania, Philadelphia, PA.

Schrand, C. M. 1997. The association between stock-price interest rate sensitivity and disclosures about derivative instruments. *The Accounting Review* 72 (January): 87–109.

Securities and Exchange Commission (SEC). 1997. *Disclosure of Accounting Policies for Derivative Financial Instruments and Derivative Commodity Instruments and Disclosure of Qualitative and Quantitative Information about Market Risk Inherent in Derivative Financial Instruments, Other Financial Instruments, and Derivative Commodity Instruments.* Release Nos. 33-7386; 34-38223; IC-22487; FR-48; International Series No.1047; File No. S7-35-95 (January 31, 1997). Washington, D.C.: Securities and Exchange Commission.

Sefcik, S., and R. Thompson. 1986. An approach to statistical inference in cross-sectional models with security abnormal returns as dependent variable. *Journal of Accounting Research* 24 (Autumn): 316–334.

Standard and Poor's. 1997. Industry survey. *Oil and Gas: Production and Marketing* (September 11).

Stulz, R. M., and R. Williamson. 1997. Identifying and quantifying exposures. Working paper, Ohio State University.

Tufano, P. 1998. The determinants of stock price exposure: Financial engineering and the gold mining industry. *Journal of Finance* 53 (June): 1015–1052.

U.S. Senate Subcommittee on Securities. 1997. *Report on Proposals by the Securities and Exchange Commission and the Financial Accounting Standards Board for the Accounting Treatment of Financial Derivatives* (April 21).

White, H. 1980. A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity. *Econometrica* (May): 817–838.

Wong, F. L. 1997. The usefulness of SFAS No. 119 disclosures to assess the foreign currency exposure of manufacturing firms. Working paper, University of California at Berkeley.