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The Interaction between Accrual Management and Hedging: Evidence from Oil and Gas Firms

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ABSTRACT: This research investigates whether oil and gas producing firms use abnormal accruals and hedging with derivatives as substitutes to manage earnings volatility. Firms engaged in oil exploration and drilling are exposed to two kinds of risks that can cause earnings volatility: oil price risk and exploration risk. Firms can use abnormal accrual choices and/or derivatives to reduce earnings volatility caused by oil price risk, but cannot directly hedge the operational risk of unsuccessful drilling. Because hedging and using abnormal accruals are costly activities, and because prior research suggests managers do not eliminate all volatility (Haushalter 2000; Barton 2001), we expect that, at the margin, managers will use these smoothing mechanisms as substitutes to manage earnings volatility. Our results suggest a sequential process whereby managers of oil and gas producing firms first determine the extent to which they will use derivatives to hedge oil price risk, and then, especially in the fourth quarter, manage residual earnings volatility by trading off abnormal accruals and hedging with derivatives to smooth income.

Keywords: *hedging; derivatives; income smoothing; abnormal or discretionary accruals; oil and gas firms.*

Data Availability: *All data used in this research are from publicly available sources.*

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I. INTRODUCTION

An active stream of research investigates whether managers smooth income by taking actions to reduce the time-series variability in reported earnings (e.g., Ronen and Sadan 1981; Schipper 1989; Hunt et al. 1996). Schrand and Elliott (1998, 276) note that managers frequently cite the objective of controlling accounting risk, ''the risk associated with variability in accounting amounts.'' DeFond and Park (1997) provide evidence that managers smooth income because of job security concerns; research on bond default risk (Smith and Stulz 1985; Trueman and Titman 1988), income taxes (Graham and Smith 1999), and information asymmetry (DeMarzo and Duffie 1995) demonstrates that reducing earnings volatility can benefit shareholders. Barth et al. (1999) document higher price-earnings multiples for firms with steadily increasing earnings, and a decline in price-earnings multiples when earnings fall after a period of increasing earnings. Yet the process by which managers smooth earnings is not well understood. To expand our understanding of this process, we examine the relation between two alternative mechanisms that managers of oil and gas producing firms can use to manage earnings variability: abnormal accruals and hedging with derivatives. Hedging dampens volatility by directly affecting the distribution of underlying cash flows, whereas smoothing with abnormal accruals directly affects only earnings volatility. In this study we ask whether, at the margin, managers of oil and gas producing firms treat hedging and accrual management as substitute mechanisms for smoothing.

This question is important for several reasons. Lambert (1984) argues that firms have incentives to use both accounting choices and real actions to smooth income. Prior research has considered real activities (e.g., Hand 1989) or accounting decisions (e.g., DeFond and Park 1997) that smooth income, but (with a few exceptions, e.g., Barton [2001]) has generally not considered both. Our study investigates whether (and how) managers draw from a portfolio of accounting tools (accruals and the full cost/successful efforts methods choice) and economic tools (e.g., hedging and diversification of operations) to manage earnings volatility in ways that reflect differences in incentives and in the costs and benefits of using the tools. Hence, researchers seeking to explain risk management behavior with regard to earnings volatility should find our evidence on the interaction between managers' operating actions and accounting decisions relevant to their research. Managers can use economic tools such as hedging along with accounting tools such as abnormal accruals to smooth income, and it is as important to study why managers choose a particular method of income smoothing as it is to understand why they smooth income in the first place. Similarly, regulators investigating income-smoothing activities (e.g., Loomis 1999) and standard setters considering accounting rules that constrain managers' accounting choices and inhibit their ability to smooth income should find our research informative because it allows for the possibility that managers may substitute between accounting and economic tools to smooth income as the costs and effectiveness of one tool change relative to that of alternative tools.

We focus on oil and gas firms that are primarily engaged in exploration and drilling. Two types of industry-specific risks affect the volatility of their earnings and, thus, their accounting risk. The first risk, fluctuations in oil prices, is due to market factors that are beyond management's control. The second risk arises from the firm's drilling success (Malmquist 1990; Fargher et al. 1997). Oil and gas producers can use derivatives to hedge oil price risk, but not the risk of unsuccessful exploration. There are no markets comparable to oil futures markets in which a firm can hedge its oil exploration risk.

If managers always preferred less volatility, then they would use all available techniques to reduce earnings volatility. However, Haushalter (2000) documents that oil and gas producers do not hedge all of their exposure to oil price risk, and Barton (2001) argues that, in general, managers strive for some nonzero level of earnings volatility. Managers can have incentives not to hedge if, for example, either they hold stock options and the value of their options increases in volatility (Tufano 1996), or they seek to coordinate risk management strategies and perhaps expose their firms to core-activity-risks that are associated with higher expected returns (Schrand and Unal 1998). Moreover, efficient hedging requires expertise, and oil and gas producers face basis risk—the risk that changes in the value of derivatives that are available for hedging purposes are not highly correlated with changes in the value of the firm's specific oil and gas production from the particular locations that the firm wishes to hedge. On the other hand, it is probably less costly to obtain expertise to manage accruals; accrual entries immediately affect reported earnings, and managers can alter accrual decisions after year-end. Of course, generally accepted accounting principles (GAAP) and scrutiny of firms by external parties such as independent auditors constrain managers' accrual choices, thereby impeding their ability to use abnormal accruals to smooth income. Because both hedging and smoothing with abnormal accruals are costly and imperfect mechanisms for managing earnings volatility, and because prior research suggests that managers do not eliminate all volatility, we expect managers to trade off one smoothing tool for the other at the margin.

Our investigation of the way oil and gas firms use hedging and smoothing with abnormal accruals to manage earnings volatility has several key features. First, to allow for the substantive differences between firms that hedge and those that do not (Geczy et al. 1997; Haushalter 2000), we analyze separately the following decisions: (1) whether to hedge, and (2) if hedged, the amount of hedging (Cragg 1971; Schrand 1994; Haushalter 2000; Barton 2001). Second, hedging and smoothing with abnormal accruals likely are endogenous elements of a firm's overall risk management strategy. We use a simultaneous equations system in which the regression explaining the extent of hedging includes the empirical proxy for the extent of smoothing with abnormal accruals, and the regression explaining the extent of smoothing with abnormal accruals includes the empirical proxy for the extent of hedging. Third, it is the abnormal component of accruals that is relevant to our investigation. Accordingly, we disaggregate total accruals and estimate the "normal" and "abnormal" components. Fourth, oil and gas producers also decide whether to use the full cost or successful efforts method to account for exploration costs, so we control for a firm's choice of the full cost or successful efforts method, and also incorporate this choice into our estimation of abnormal accruals. Fifth, we control for other determinants of hedging and smoothing with abnormal accruals.

Two prior studies have examined the relation between accounting choice and hedging. Petersen and Thiagarajan (2000) report case study evidence of two gold-mining firms; one managed risk with derivatives while the other used accounting estimates to smooth earnings. Barton (2001) documents a simultaneous and negative relation between foreign exchange and interest rate derivative holdings and abnormal accruals in a broad cross-sectional subset of *Fortune 500* firms. His results are largely consistent with our substitution hypothesis.

Our study complements and extends Barton (2001) by focusing on commodity derivatives in a single industry. This allows us to identify and measure more precisely our sample firms' inherent market and operational risks (Hughes 2000). Thus, we can compute a hedging ratio that more accurately pinpoints the proportion of risk exposure hedged, and we can estimate an important operational risk (exploration risk) and examine its interaction with hedging and smoothing with abnormal accruals. Focusing on a single industry also allows us to hold production functions relatively constant in the cross-sectional analysis and to identify the effect of an important accounting choice (full cost or successful efforts) on abnormal accruals. In contrast to Barton's (2001) use of the absolute value of abnormal accruals, we compute a smoothing ratio—the standard deviation of earnings before abnormal accruals to the standard deviation of reported earnings—that captures the direct effect of using abnormal accruals to smooth income. Thus, we re-examine the substitution hypothesis regarding the extent of hedging and smoothing with abnormal accruals in a single industry setting where our endogenous variables are likely less subject to measurement error. The main costs of our single-industry design are a smaller sample and an inability to generalize beyond oil and gas producing firms.

Our results indicate that the extent of smoothing with abnormal accruals is not a significant determinant of the amount of hedging. In contrast, the extent of hedging is a significant determinant of the extent of smoothing with abnormal accruals. Specifically, we find that even after controlling for factors affecting cross-sectional differences in incentives to smooth, the more managers hedge with derivatives, the less they smooth with abnormal accruals. The results are consistent with a sequential process whereby managers first make hedging decisions, and then, at the margin, substitute between abnormal accruals and hedging with derivatives to smooth earnings. Detailed analysis indicates that fourth-quarter abnormal accruals reflect this trade-off between the two smoothing mechanisms.

Our inference of a sequential hedging-then-abnormal-accruals decision process contrasts with Barton's (2001) overall conclusion of a simultaneous process whereby abnormal accruals affect hedging, as well as hedging affecting abnormal accruals. We believe that the difference in our inferences is most likely due to our ability to measure more accurately the extent of hedging and smoothing with abnormal accruals, or to unique features of the oil and gas industry. Unfortunately, however, we cannot rule out the possibility that lower power tests resulting from our smaller sample size contributed to our conclusion that abnormal accruals do not play a significant role in explaining the extent of hedging.

We organize the remainder of the paper as follows. First, in Section II we develop the motivation for expecting managers of oil and gas producers to view hedging oil price risk and smoothing with abnormal accruals as substitute devices for managing earnings volatility. We then discuss the empirical design in Section III and identify the explanatory variables for the hedging and the smoothing with abnormal accruals regressions. Section IV presents descriptive statistics, the primary results, and additional analyses, and Section V concludes.

II. RESEARCH HYPOTHESIS

Exploration (or drilling) risk is the risk that exploring for oil and gas will result in "dry" wells. Exploration risk introduces variation in the quantities of oil and gas produced, thereby inducing variability in a firm's cash flows. Cash flow (and thus earnings) volatility also arises from oil price risk—the risk of fluctuating revenues due to volatile oil and gas prices. A firm can reduce oil price risk by hedging with derivative instruments; however, such instruments cannot hedge exploration risk.

If managers preferred to minimize cash flow volatility and earnings volatility, then oil and gas producing firms would hedge all oil price risk they face *and* use other mechanisms to reduce the volatility induced by unhedgeable exploration risk. That is, managers would use these volatility-controlling mechanisms in a complementary, or reinforcing, fashion to reduce volatility. Hence, in addition to hedging oil price risk to reduce cash flow volatility, managers would use abnormal accruals (AACs) to smooth reported earnings—for example, to maximize share price (e.g., Barth et al. 1999), to lower the firm's expected tax liability (Smith and Stulz 1985), or perhaps to communicate private information to investors about expected future cash flow volatility (Subramanyam 1996). However, managers can have incentives against minimizing volatility. For instance, managers with stock options may opt not to hedge in the hope of increasing stock price volatility (Tufano 1996; Rajgopal and Shevlin 2002). Further, managers may want to increase their exposure to particular risks where they anticipate higher returns, especially in core activities, while at the same time hedging volatility from other risks. Schrand and Unal (1998) find such evidence in the thrift industry and conclude it is indicative of a coordinated risk-management strategy. In our setting, this suggests that managers might hedge oil price risk while exposing their firms to exploration risk, or perhaps hedge oil price risk less, the lower their firm's exploration risk.

Moreover, hedging and smoothing with AACs are costly and imperfect tools for managing volatility, and thus at some point one or the other may not be cost effective. Prior research on hedging (Mian 1996; Geczy et al. 1997; Haushalter 2000) links firm size and hedging. Larger firms have the economies of scale in information and transactions costs to hedge efficiently (e.g., hiring personnel with the experience to manage a derivatives program). In addition, value changes in oil and gas produced in a firm's locations may not necessarily be highly correlated with the value changes in the oil and gas produced in other locations that are used as the benchmarks for derivatives; this gives rise to basis risk (Haushalter 2000). Further, it is likely more costly to obtain expertise in hedging than expertise in accrual management, and managers can make important current-period accrual decisions after year-end. Of course, there are impediments to using AACs to smooth. These include monitoring by auditors and financial analysts, accrual reversals, and other constraints under GAAP.

In our sample, oil price risk and exploration risk are positively correlated ($\rho = 0.16$, $p = 0.07$, two-tailed test).[1] Thus, managers can use both hedging and smoothing with AACs to reduce earnings volatility induced by these risks. We therefore expect managers to use both mechanisms to manage volatility, consistent with Barton's (2001) evidence. However, the costs and limitations of both hedging and using AACs as tools for managing volatility, as well as differing incentives regarding the management of volatility, suggest that managers do not use hedging with derivatives and smoothing with AACs to *eliminate* volatility. Instead, we expect that once managers decide to use both hedging and smoothing with AACs to smooth earnings, they will make trade-offs between these two smoothing instruments at the margin to achieve some benchmark, nonzero level of volatility.

Our basic research hypothesis is as follows:

H1: *Ceteris paribus,* managers of oil and gas firms use hedging with derivatives and smoothing with abnormal accruals as substitute mechanisms at the margin to manage earnings volatility induced by oil price risk and exploration risk.

As discussed in the next section, we employ a simultaneous equation design and control for factors affecting cross-sectional differences in incentives for smoothing.

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[1] We estimate an oil price beta for each firm-year as our measure of oil price risk, by regressing firms' daily stock returns on market returns and percentage changes in oil prices. The mean oil price beta is reliably positive, consistent with firms not being fully hedged. Note that if oil price and exploration risks were negatively related, hedging oil price risk would *increase* earnings volatility, because earnings shocks from oil price fluctuations would be hedged and therefore would not be available to offset shocks from exploration activities.

III. EMPIRICAL DESIGN

Empirical Models

Prior research (Geczy et al. 1997, 1999) reports significant differences between hedgers and non-hedgers, and Haushalter (2000) and Barton (2001) find the determinants of the decision whether to hedge differ from the determinants of the extent of hedging, given that a firm hedges. Thus, our analysis separates the decision of whether to hedge from the decision of how much to hedge (Schrand 1994; Haushalter 2000). Then, given that a firm hedges, we allow managers' decisions about the extent of hedging and smoothing with AACs to be simultaneous; i.e., these decisions are endogenous to an entity's risk management strategy, and decisions about each can affect the other (Barton 2001). Therefore, (1) the extent of smoothing with AACs is an endogenous variable in the extent-of-hedging equation, and (2) the extent of hedging is an endogenous variable in the extent-of-smoothing with AACs equation.

We evaluate firm *i*'s year *t* decision whether to hedge as follows:

$$Hedgers_{it} = \zeta_0 + \zeta_1 Explrisk_{it} + \zeta_2 FullCost_i + \zeta_3 HdgControls_{it} + \xi_{it}, \tag{1}$$

and then, given that hedging occurs, we simultaneously assess the decisions about the extent of hedging and the extent of smoothing with AACs, using the following two equations:

$$Hedging\ ratio_{it} = \gamma_0 + \gamma_1 PredAAC\ smoothing\ ratio_{it} + \gamma_2 Explrisk_{it} + \gamma_3 FullCost_i + \gamma_4 HdgControls_{it} + \gamma_5 InvMills_{it} + \omega_{it} \tag{2}$$

$$AAC\ Smoothing\ ratio_{it} = \phi_0 + \phi_1 PredHedging\ ratio_{it} + \phi_2 Explrisk_{it} + \phi_3 FullCost_i + \phi_4 AACControls_{it} + \phi_5 InvMills_{it} + \kappa_{it} \tag{3}$$

where:

$Hedgers_{it}$ = 1 if firm *i* holds a nonzero derivative position at fiscal *t* year-end, and 0 otherwise;

$Hedging\ ratio_{it}$ = quantity of oil and gas production that firm *i* hedged at fiscal *t* year-end, scaled by quantity of year *t* production;

$PredHedging\ ratio_{it}$ = predicted value of $Hedging\ ratio_{it}$ from the first stage of two-stage least squares (2SLS);

$AAC\ smoothing\ ratio_{it}$ ≡ smoothing with abnormal accruals ratio = standard deviation of firm *i*'s quarterly income before abnormal accruals and extraordinary items in year *t* divided by standard deviation of firm *i*'s quarterly income before extraordinary items in year *t*;

$PredAAC\ smoothing\ ratio_{it}$ = predicted value of $AAC\ smoothing\ ratio_{it}$ from the first stage of 2SLS;

$Explrisk_{it}$ ≡ exploration risk = firm *i*'s year *t* score from a factor analysis of two exploration risk proxies, exploration expenditures, and Sunder's (1976) variance;

$FullCost_i$ = 1 if firm *i* uses full cost, and 0 if it uses successful efforts;

$HdgControls_{it}$ and $AACControls_{it}$ = additional control variables for the hedging and smoothing with abnormal accruals equations, respectively; and

$InvMills_{it}$ ≡ inverse Mills ratio = self-selection adjustment from estimating Equation (1).

We employ an estimation approach based on Cragg's (1971) self-selection model (see also Heckman 1979). We model the initial decision of whether to hedge as a binomial probit regression, estimated using all firm-years in the sample. Next, we consider only firm-years with hedging, and we simultaneously estimate regressions for the extent of hedging and extent of smoothing with AACs. Because a firm's decision whether to hedge is not random, selectivity bias can cause ξ_{it}, ω_{it}, and κ_{it} in Equations (1)–(3) to be correlated, which can lead to biased estimates of the regression parameters. Thus, we incorporate the adjustment for self-selection (the inverse Mills ratio) from the estimated probit model into the hedging Equation (2) and the AAC smoothing Equation (3). We then estimate Equations (2)–(3) using 2SLS, which is valid asymptotically and subject to other limitations (Kennedy 1998, chapter 10; Holthausen et al. 1995, 296–297). In the first stage, we regress each endogenous variable (*AAC smoothing ratio* and *Hedging ratio*) on the exogenous variables and then compute predicted values of the hedging and smoothing ratios. We label the resulting predicted variables *PredHedging ratio* and *PredAAC smoothing ratio* and use them as endogenous variables in the second stage of the estimation along with the exogenous variables.

We test our basic hypothesis by estimating Equations (2) and (3). If the extent of hedging and the extent of smoothing with AACs are substitutes, and if managers make both decisions simultaneously, then the coefficient on $PredAAC\ smoothing\ ratio_{it}$ in Equation (2) should be negative ($\gamma_1 < 0$) and the coefficient on $PredHedging\ ratio_{it}$ in Equation (3) should be negative ($\phi_1 < 0$). Note that if managers make the decisions sequentially, then the negative relation will occur in Equation (2) or Equation (3), but not in both, and if managers do not use hedging and smoothing with AACs as substitutes, then neither γ_1 nor ϕ_1 will be negative.

Sample Selection

We begin the empirical analysis in 1993 because few firms made voluntary disclosures about derivatives prior to that time. Because we can identify their inherent risks, we focus on oil and gas exploration and producing firms (SIC code 1311) and exclude large, vertically integrated firms that explore, extract, transport, refine, and distribute oil and gas products. We initially identified 163 companies in the 1996 Compustat annual files. We deleted (1) thirteen firms that were undergoing bankruptcy or liquidation proceedings, or experiencing going-concern problems, (2) three firms that were subsidiaries of other firms in the sample, (3) four firms that switched from full cost to successful efforts accounting, or vice versa, during the period 1993 to 1996, and (4) four firms for which financial statements were not available for the period. The remaining sample is 139 firms from the period 1993–1996. However, 124 firm-years lack data to compute the hedging ratio, an additional 182 firm-years lack data to calculate the explanatory variables for the hedging regressions, and another 14 firm-years lack data to compute the variables for the smoothing with AACs regression. The final sample is 236 firm-years. In untabulated results, we compare the final sample with the deleted firm-years that have at least some of the required data, and find the following significant differences: the excluded firm-years reflect smaller firms, a lower occurrence of hedging, less extensive hedging when hedging occurs, and less extensive smoothing with AACs than the firm-years included in our sample.

Dependent Variables

Table 1 provides definitions and data sources for all of the study's variables. We use annual report or 10-K disclosures of year-end commodity derivative positions to document the occurrence of hedging ($Hedgers_{it}$) and the extent of hedging ($Hedging\ ratio_{it}$). The numerator of *Hedging ratio* is the quantity of production hedged, and the denominator is the quantity of production, which reflects the firm's exposure to oil price risk (Haushalter 2000).[2,3] Appendix A offers an example of derivative disclosures and illustrates the computation of *Hedging ratio*.

Our measure of smoothing with abnormal accruals, $AAC\ smoothing\ ratio_{it}$, equals the standard deviation of firm *i*'s year *t* quarterly earnings before abnormal accruals divided by the standard deviation of its year *t* quarterly earnings; i.e., $\sigma_{EBAAC}/\sigma_{E}$ (Hunt et al. 1997). Values of *AAC smoothing ratio* in excess of 1 indicate more variability in earnings before abnormal accruals than in earnings after abnormal accruals, consistent with smoothing via AACs.[4] We compute *AAC smoothing ratio* for each firm-year based on quarterly data. Specifically, we define (1) earnings as income before extraordinary items and (2) earnings before abnormal accruals as operating cash flows plus normal accruals; we scale each by total assets of the previous quarter. We measure quarterly operating cash flows following Han and Wang (1998, notes 10 and 11), and compute quarterly normal accruals by adapting the modified cross-sectional Jones model (Dechow et al. 1995) to include interactions of each explanatory variable with a dummy variable that equals 1 (0) if a firm uses (does not use) full cost to account for exploration costs. We discuss the adapted accruals model and the motivation for it below.[5]

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[2] Barton (2001) uses lagged total assets as the denominator in his derivatives variable. However, Tufano (1996) and Wong (2000) argue that a firm's hedge position should be evaluated with respect to what is being hedged. In addition, Barton (2001, note 4) uses the notional amount of derivatives reported under SFAS No. 119 (FASB 1994) as the numerator in his derivatives variable. Wong (2000, 393) notes that SFAS No. 119 aggregated notional-amount disclosures do not distinguish clearly whether a firm has assumed a long or short position. We do not face that problem because oil and gas producing firms are naturally long in oil price risk. However, because we rely on commodity derivative data that firms voluntarily disclose, our analysis excludes firms that hedge oil price risk but do not disclose that fact. Also, we base our measure on a firm's net derivative position. Although the net position reflects the derivatives firms held for trading purposes, this measurement error should not materially affect our analysis because only 7 percent of our firm-years use derivatives for trading purposes.

[3] The numerator of *Hedging ratio* is the total notional quantity of oil and gas hedged, which we determine by aggregating across various derivative types. However, options are one-sided contracts, whereas swaps, forwards, and futures are two-sided contracts (there are receivable/payable implications regardless of whether the oil price rises above or falls below the strike price of the derivative). We find that managers use options in only 10 percent of our sample firm-years. Hence, aggregating across instrument types is unlikely to induce significant measurement error in our hedging ratio variable.

[4] Barton (2001) uses the absolute value of abnormal accruals. This is an indirect measure that is subject to the limitation that larger absolute values of abnormal accruals may not always result in smoother earnings.

[5] We examined in depth one-third of our sample firms' financial statements and notes to identify the common types of accounts reflecting accruals. We find that operating current assets and liabilities include accounts receivable, inventories, prepaid expenses, payables, accrued expenses, and unearned revenues. Since these accounts are typical of companies in general, the modified Jones model would seem to be appropriate in our oil and gas setting. Operating accounts that reflect oil and gas exploration and production activities include (1) receivables (payables) from deliveries of natural gas due to excess production (underproduction) where revenue is based on a firm's working interest or entitlement in a field's production, and (2) unearned oil and gas revenues where firms receive advance payments for deliveries of future production at a certain price. In Section IV, we assess the sensitivity of the results to measurement error in estimating abnormal accruals (Bernard and Skinner 1996), including the effect of special items and of acquisitions and divestitures (Collins and Hribar 2000).

TABLE 1
Variable Definitions and Data Sources

Dependent/Endogenous Variables:

$Hedgers_{it}$ = indicator variable that equals 1 if firm i holds a nonzero derivative position at fiscal t year-end, and 0 otherwise (Source: 10-K, Annual Report).

$Hedging\ ratio_{it}$ = quantity of oil and gas production firm i hedged at fiscal t year-end, scaled by quantity of year t production (Source: 10-K, Annual Report; see Appendix A).

$AAC\ smoothing\ ratio_{it}$ ≡ smoothing with abnormal accruals ratio = standard deviation of firm i's quarterly income before abnormal accruals and extraordinary items in year t divided by standard deviation of its quarterly earnings before extraordinary items in year t, i.e., σ_{EBAAC}/σ_E (Hunt et al. 1997). The following summarizes key variables used or computed in quarter q for firm i (variables are scaled by total assets of the previous quarter, Compustat quarterly data item #44):

$$\text{EBAAC}_{iq} = \text{CFO}_{iq} + \text{NAC}_{iq}$$
$$\text{TotalAC}_{iq} = \text{EBEI}_{iq} - \text{CFO}_{iq}$$
$$\text{CFO}_{iq} = \text{WCO}_{iq} - \Delta\text{AR}_{iq} - \Delta\text{INV}_{iq} - \Delta\text{OCA}_{iq} + \Delta\text{AP}_{iq} + \Delta TP_{iq} + \Delta\text{OCL}_{iq}$$

where EBAAC_{iq} = earnings before abnormal accruals; CFO_{iq} = cash flows from operations; NAC_{iq} = normal accruals computed using an adaptation of the modified cross-sectional Jones model that incorporates a firm's choice of full cost or successful efforts accounting (Equation [4] in the text); TotalAC_{iq} ≡ total accruals; EBEI_{iq} = income before extraordinary items (Compustat quarterly data item #69); WCO_{iq} = working capital from operations (following Han and Wang 1998, notes 10 and 11) = EBEI_{iq} ± noncash, nonoperating expenses and revenues (Compustat quarterly data item #76 + #77 + #78 + #79 + #80 + #81 + #102); ΔAR_{iq} = change in accounts receivable (Compustat quarterly data item #37); ΔINV_{iq} = change in inventory (#38); ΔOCA_{iq} = change in other current assets (#39); ΔAP_{iq} = change in accounts payable (#46); ΔTP_{iq} = change in taxes payable (#47); ΔOCL_{iq} = change in other current liabilities (#48). We adjust data items reported on a cumulative basis in Compustat to reflect quarterly values, and changes in working capital accounts are the differences between the current amount and the prior quarter's amount.

Explanatory Variables—Hedging and Smoothing with AACs Regressions:

$Explrisk_{it}$ ≡ exploration risk = score from a factor analysis of: (1) firm i's year t oil and gas exploration expenditures, and (2) the firm's year t variance of net operating cash flows, assuming it is in steady-state (Sunder 1976), both scaled by the firm's year-end reserve values. We identify from factor analysis one factor having an eigenvalue greater than 1 (Source: 10-K, Annual Report; Appendix B details the computation of Sunder's variance).

$FullCost_i$ = indicator variable that equals 1 if firm i uses the full cost method, and 0 if it uses successful efforts (Source: Compustat annual footnote 31, 10-K, Annual Report).

$Leverage_{it}$ = long-term debt scaled by market value of equity, both measured at fiscal t year-end (Compustat annual data item #9/[#199 × #25]).

M/B_{it} ≡ market-to-book ratio = ratio of market value of equity to book value of equity of firm i, each measured at fiscal t year-end (Compustat annual data item [#199 × #25]/[#60 + #30]).

(*Continued on next page*)

TABLE 1 (Continued)

Tax_{it} = indicator variable that equals 1 if firm i is profitable (i.e., income before extraordinary items > 0) in year t and has NOL tax carryforwards at fiscal t year-end, and 0 otherwise (Compustat annual data item #18 and #52, respectively).

$MgrlOwn_{it}$ ≡ managerial ownership = percentage of firm i's shares held by insiders in year t (Source: Compact D-SEC).

$Stock\ options_{it}$ = number of exercisable stock options managers and employees hold, scaled by number of shares outstanding, both measured at fiscal t year-end (Source: 10-K, Annual Report).

$InstitOwn_{it}$ = percentage of firm i's total shares outstanding held by institutions in year t (Source: Compact D-SEC).

$Firm\ size_{it}$ = log of market value of equity of firm i at fiscal t year-end (Compustat annual data item #199 × #25).

Explanatory Variables Unique to Hedging Regressions:

σRET_{it} ≡ standard deviation of returns = computed using firm i's monthly returns over fiscal year t (Source: CRSP).

$Production\ exposed_{it}$ = proportion of firm i's year t production exposed to basis risk because it is produced in locations other than Arkansas, Kansas, Louisiana, Oklahoma, and Texas (Source: 10-K, Annual Report).

$Intl\ production_{it}$ ≡ international production = indicator variable that equals 1 if firm i has production in year t at international locations, and 0 otherwise (Source: 10-K, Annual Report).

$O\&G\ Production_{it}$ ≡ oil and gas production = percentage of firm i's fiscal year t sales from oil and gas production (Source: 10-K).

$Cash_{it}$ = firm i's cash scaled by its market value of equity at fiscal t year-end (Compustat annual data item #1/[#199 × #25]).

Explanatory Variables Unique to Smoothing with AACs Regression:

$DivPayout_{it}$ ≡ dividend payout ratio = dividends per share to common shareholders of firm i in fiscal year t divided by earnings per share before extraordinary items in year t (Compustat annual data item #26/#58).

$MarkToMarket_{it}$ = indicator variable that equals 1 if firm i trades in derivatives in year t, and 0 otherwise (Source: 10-K, Annual Report).

Controls: Exploration Risk and Accounting for Exploration Costs

Our proxy for exploration risk ($Explrisk_{it}$) is the score from a factor analysis of (1) a firm's annual oil and gas exploration expenditures (Malmquist 1990), and (2) the firm's variance of net operating cash flows, assuming it is in steady-state (Sunder 1976). In Appendix B we summarize the theoretical derivation of Sunder's variance, note the assumptions we make to estimate it, and illustrate its computation. We scale exploration costs and Sunder's variance by the firm's year-end reserve values and identify from factor analysis one factor having an eigenvalue greater than 1 (not shown). This factor retains 85 percent of the variation in the input variables. Using the estimated weights from the factor analysis, we linearly combine the two input variables to derive factor scores for each firm-year. Higher factor scores indicate more exposure to exploration risk and hence greater concern about earnings volatility.

The full cost method of accounting for exploration costs views an entire drilling area as an asset, and firms capitalize and amortize all exploration costs against future earnings.

Under successful efforts, however, only productive wells are assets. A firm using successful efforts expenses the costs of a dry well in the period it determines the well is uneconomic, rather than amortizing all exploration costs over a longer period of time. Hence, full cost typically generates a smoother time-series of earnings than successful efforts,[6] so full cost firms may be less inclined to hedge or smooth with AACs. However, full cost firms may be fundamentally different from successful efforts firms (Malmquist 1990), their earnings streams may reflect such fundamental differences (Sunder 1976), and they may face different levels of overall risk. It is thus unclear whether (or how) the use of full cost or successful efforts is associated with current period hedging and smoothing with AACs. We control for firms' use of full cost or successful efforts by including the indicator variable $FullCost_i$ in both the hedging and the smoothing-with-AACs equations, without making a directional prediction.[7] Furthermore, given the possibility of substantive differences between full cost and successful efforts firms and the two methods' differential effects on the time-series of earnings and also on property, plant, and equipment, and therefore total assets, we adapt the modified Jones model in estimating accrual components to account for a firm's choice of full cost or successful efforts. Specifically, we estimate the following model:

$$\begin{aligned} TotalAC_{iq}/TA_{iq-1} = {} & a_1(1/TA_{iq-1}) + a_2[(\Delta Rev_{iq} - \Delta Rec_{iq})/TA_{iq-1}] \\ & + a_3(PPE_{iq}/TA_{iq-1}) + a_{1a}(1/TA_{iq-1})D_i \\ & + a_{2a}[(\Delta Rev_{iq} - \Delta Rec_{iq})/TA_{iq-1}]D_i \\ & + a_{3a}(PPE_{iq}/TA_{iq-1})D_i + v_{iq} \end{aligned} \tag{4}$$

where:

$TotalAC_{iq}$ = total accruals for firm i in quarter q, measured as income before extraordinary items − cash flows from operations;
TA_{iq-1} = firm i's total assets in quarter $q - 1$;
ΔRev_{iq} = firm i's change in revenues from quarter $q - 1$ to q;
ΔRec_{iq} = firm i's change in receivables from quarter $q - 1$ to q;
PPE_{iq} = firm i's gross property, plant, and equipment in quarter q;
D_i = 1 (0) if firm i uses the full cost (successful efforts) method; and
v_{iq} = residual from ordinary least squares (OLS) estimation = abnormal accruals.

Other Control Variables

Equations (1)–(3) control for a number of additional factors we expect to affect hedging and/or smoothing with AACs.

[6] However, full cost induces greater earnings variability when sharp oil-price declines necessitate reserve write-downs. Sharp annual price declines did not occur in our sample period (Rajgopal 1999).

[7] Treating the full cost/successful efforts (FC/SE) choice as exogenous is a limitation of our analysis. We perform sensitivity checks by interacting *FullCost* with variables in the hedging and smoothing-with-AACs models. From the set of firms with the necessary data, only four firms (3 percent) changed their FC/SE choice over our test period, and only six firms switched during the preceding 12 years. Firms likely find it less costly to smooth earnings by using AACs or hedging than by changing their accounting methods for exploration costs. Furthermore, it seems unlikely that the original determinants of firms' FC/SE choices remained constant since firms made their choices, and the results in Table 2, Panel C indicate that full cost and successful efforts users differ in ways that Malmquist (1990) did not identify. It is therefore beyond the scope of our study to model the determinants of the FC/SE choice for our oil and gas firms.

Additional Factors Expected to Affect Both Hedging and Smoothing with AACs

Financial leverage. The greater a firm's debt, the more likely it will hedge. Debt contracts typically constrain firms to reduce the probability of financial distress, and hedging mitigates extremely negative cash flows (Geczy et al. 1997; Graham and Rogers 1999). Smoothing with AACs also reduces the likelihood of reporting severe losses and thus of technical default. We use long-term debt scaled by market value of equity as our *Leverage* proxy.

Investment opportunity set. The more growth opportunities available, the more likely a firm will hedge cash flows to assure the availability of funds. Growth opportunities also provide an incentive to smooth earnings using AACs because earnings volatility reflects firm risk (Beaver et al. 1970) and thus potentially adversely affects the cost of the capital needed to fund investment projects. We use the market-to-book (*M/B*) ratio to proxy for growth opportunities.

Additionally, Froot et al. (1993) argue that hedging mitigates underinvestment by reducing a firm's dependence on, and costs of, external financing. If external financing is more costly than internally generated funds, then a firm that does not hedge to reduce the volatility in its operating cash flows may underinvest if it is too costly to raise funds externally. Hedging thus allows the firm to avoid unnecessary fluctuations in either investment spending or externally obtained financing. We proxy for the costs of underinvestment using the interaction of growth opportunities and debt financing, $M/B \times Leverage$ (Geczy et al. 1997), and predict a positive relation between this interaction and both hedging and smoothing with AACs.

Income taxes. Graham and Smith (1999) show that firms with existing net operating loss carryforwards (NOLs) have an incentive to hedge if they expect to be profitable. The incentive derives from the asymmetric tax treatment of profits and losses and limitations to sell or immediately use tax preference items, such as NOLs (Smith and Stulz 1985; Graham and Rogers 1999). The indicator variable *Tax* equals 1 in a year when the firm is profitable and has NOL tax carryforwards, and so has a tax incentive to smooth, either by hedging or by using AACs.

Managerial wealth and risk. If risk-averse managers cannot diversify firm-specific risks or if they believe that the market perceives lower earnings volatility as reflecting lower firm riskiness, then they have more incentive to hedge or smooth with AACs, the larger their holdings in their firms' stocks (Smith and Stulz 1985; Guay 1999). On the other hand, owner-controlled firms provide additional monitoring and tend to manage earnings less (Warfield et al. 1995). We proxy managerial ownership (*MgrlOwn*) by using the percentage of firm *i*'s shares held by insiders, but we do not predict the direction of its association with hedging and smoothing with AACs.

Managers holding more stock options have less incentive to dampen volatility if the value of options increases in volatility (Tufano 1996). This incentive is more salient for exercisable options (Schrand and Unal 1998; Haushalter 2000). Thus, we expect hedging and smoothing with AACs to be inversely related to *Stock options,* the number of exercisable stock options managers and employees hold, scaled by the number of shares outstanding, both as of year-end.[8]

[8] Sensitivity of options to returns or returns volatility is arguably a better proxy for stock option based earnings management incentives. However, computing such sensitivity requires extensive information, such as time to maturity and exercise price of new and previously granted options. Footnote data do not provide full disclosure of previously granted options, and *Execucomp* includes complete data for only 25 sample firms.

Institutional ownership. External parties cannot observe managerial quality, making it difficult to disentangle profits due to managerial ability from profits due to exogenous shocks (DeMarzo and Duffie 1995). The less the external monitoring of the firm, the greater managers' incentives to hedge cash flow volatility, and to smooth earnings with AACs, to facilitate the market's assessment of their skills. We use the extent of institutional ownership (*InstitOwn*) to proxy for the degree of external monitoring, based on the assumption that more extensive institutional ownership leads to monitoring that in turn reduces information asymmetry between investors and managers (Geczy et al. 1997). These arguments suggest a negative relation between *InstitOwn* and both *Hedging ratio* and *AAC smoothing ratio*. On the other hand, external monitoring likely increases pressure on managers to dampen volatility—i.e., to make earnings more predictable (Levitt 1998; Loomis 1999), suggesting a positive relation between extent of institutional ownership and both hedging and smoothing with AACs. Accordingly, we do not sign the predicted association.[9]

Firm size. Larger firms enjoy the economies of scale to obtain expertise and lower average transaction costs needed to hedge effectively (Mian 1996; Geczy et al. 1997; Haushalter 2000). We use *Firm size,* defined as the log of a firm's market value of equity at year-end, as our proxy for scale, and predict a positive relation between firm size and hedging.

With regard to smoothing with AACs, note that larger firms are also subject to more external monitoring, which constrains managers' ability to smooth earnings with AACs. However, larger firms are followed by more analysts (Bhushan 1989) and arguably face more pressure to report more predictable earnings (Fox 1997). Thus, we do not predict the direction of the relation between *Firm size* and *AAC smoothing ratio,* in contrast to the predicted positive link between *Firm size* and hedging.

Year indicators. We include a dummy variable for each year (except 1996) to proxy for changes in unspecified macroeconomic factors, which are cross-sectional constants (such as oil prices). We thus estimate fixed-effects models.

Factors to Discriminate between Hedging and Smoothing with Abnormal Accruals

Hedging: Cost of capital. We use the standard deviation of the firm's monthly returns over the fiscal year (σRET) as a proxy for the cost of capital associated with cash flow volatility (Minton and Schrand 1999). Firms have a greater incentive to hedge, the greater the σRET. However, we can observe σRET only *after* the firm has hedged. To the extent σRET incorporates the effects of hedging, and hedging has successfully reduced σRET to below σRET of non-hedgers, we would expect lower σRET to result from more extensive hedging, and therefore predict a negative sign. Also in our regression model, σRET captures stock return volatility incremental to that contributed by exploration risk because exploration risk is a separate independent variable in the hedge/no hedge and *Hedging ratio* regressions.

Hedging: Basis risk. Haushalter (2000) reports that in Arkansas, Kansas, Louisiana, Oklahoma, and Texas, spot prices for oil and gas are highly correlated with the two benchmark grades of oil and gas (West Texas Intermediate and Henry Hub) on which most derivative contracts are written. Production in these locations faces relatively low basis risk, making hedging effective. On the other hand, hedging will be less effective for production in other locations, and thus managers will be less likely to hedge. Our proxy for basis risk,

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[9] Including indicator variables for exchange listing and for Big 6 auditor as additional proxies for external monitoring does not affect the study's inferences.

Production exposed, is the proportion of the firm's annual production *not* located in Arkansas, Kansas, Louisiana, Oklahoma, and Texas, and we predict a negative relation between *Production exposed* and hedging. We also control for *Intl production,* which equals 1 if a firm has oil and gas production at international locations, and 0 otherwise, because it is more difficult to identify derivatives with value changes that are highly correlated with changes in the value of foreign production.

Hedging: Substitutes. Diversification of operations is a possible hedging substitute because shocks in one line of business may offset shocks in other lines of business. We expect managers are more likely to hedge, the less diversified the firm's operations (i.e., the larger the portion of a firm's revenues derived from oil and gas production, as proxied by the percentage of annual sales from oil and gas production, *O&G Production*).

If managers hedge to dampen cash flow volatility, then the availability of cash should reduce the need, if not substitute, for hedging (Haushalter 2000). We expect that the more cash on hand, the less managers will hedge. *Cash* is defined as cash scaled by year-end market value of equity.

Smoothing with AACs: Dividend payout ratio. Volatility in earnings affects firms' ability to pay dividends because dividend restrictions in bond covenants are usually based on earnings realizations (Smith and Warner 1979). We compute dividend payout ratio (*DivPayout*) as dividends to common shareholders divided by earnings before extraordinary items, and predict a positive relation with *AAC smoothing ratio*.

Smoothing with AACs: Accounting for derivatives used for trading purposes. Firms that use derivatives for trading purposes use mark-to-market accounting, which can induce earnings volatility. If firms engaged in derivative trading also are concerned about earnings volatility, then we expect them to use AACs to smooth earnings. We use a dummy variable, *MarkToMarket,* which equals 1 if a firm trades in derivatives in year *t*, and 0 otherwise.

IV. DATA AND RESULTS

Sample Description

Panel A of Table 2 reports descriptive statistics for the full sample. With regard to the dependent variables, 44 percent of firm-years hedge oil price risk with derivatives (*Hedgers*), and firms on average hedge 33 percent of production (*Hedging ratio*). There is considerable variation in the proportion of production hedged (the coefficient of variation equals 3.58), and more often than not oil and gas producers do not hedge, consistent with Haushalter (2000). In the subset of firm-years with hedging (not shown), on which we conduct the study's main analyses, the mean (median) proportion of production hedged is 66 percent (30 percent).

Across all firm-years, the mean *AAC smoothing ratio* is 4.20 (median = 2.17). In untabulated results, a t-test rejects the null hypothesis that the mean equals 1 (t = 9.71) and *AAC smoothing ratio* values exceed 1 in 64 percent of firm-years. In firm-years with hedging, the mean *AAC smoothing ratio* equals 5.41 (median = 3.05); the mean reliably exceeds 1, as do 72 percent of individual *AAC smoothing ratio* values (not shown). These results are consistent with pervasive and nontrivial smoothing.

Turning to the independent variables, firms in our sample are almost evenly split between those using full cost and those using successful efforts.[10] There is substantial variation across firm-years in *Explrisk* (coefficient of variation = 4.44) and in growth opportunities,

[10] Prior studies find that large firms typically use successful efforts (Foster 1980), but there is no significant relation between *Firm size* and *FullCost* in our sample. The likely explanation for the difference is that our sample includes oil and gas exploration and drilling firms, and excludes large, vertically integrated companies.

TABLE 2
Descriptive Statistics and Univariate Analyses of the Sample of Oil and Gas Producing Firms (SIC Code 1311) over the Period 1993–1996

Panel A: Descriptive Statistics of the Full Sample (n = 236 firm-years)

Variable	*Mean*	*Median*	*Standard Deviation*	*1st Quartile*	*3rd Quartile*
Dependent variables:					
Hedgers	0.44	0	0.50	0	1
Hedging ratio	0.33	0	1.17	0	0.26
AAC smoothing ratio	4.20	2.17	5.09	0.58	6.25
Common explanatory variables:					
Explrisk	0.13	0.01	0.58	0.00	0.05
FullCost	0.50	0	0.50	0	1
Leverage	0.42	0.24	0.65	0.07	0.47
M/B	1.45	1.34	5.05	0.83	2.02
Tax	0.15	0	0.36	0	1
MgrlOwn (percent)	19.13	7.51	25.45	1.4	25.76
Stock options	0.07	0.04	0.12	0.02	0.08
InstitOwn (percent)	33.19	28.98	28.46	1.50	59.32
Firm size (millions of $)	522.64	65.03	1125.30	23.70	333.32
Variables for hedging equations:					
σRET	0.12	0.10	0.07	0.08	0.14
Production exposed (percent)	24.22	6	33.91	0	33
Intl production	0.36	0	0.48	0	1
O&G Production (percent)	89.11	100	17.64	84	100
Cash	0.11	0.05	0.18	0.01	0.12
Variables for AAC smoothing equation:					
DivPayout	0.72	0	1.68	0	0.40
MarkToMarket	0.07	0	0.26	0	0

(*Continued on next page*)

TABLE 2 (Continued)

Panel B: Differences between Hedgers (n = 103 firm-years) and Non-Hedgers (n = 133 firm-years)

Variable	Hypothesized Sign[a]	*Medians* Hedger (H)	Non-Hedger (NH)	*Wilcoxon Rank Sum Test* Higher Score	p-value[b]	*t-test of Diffferences in Means* t-statistic	p-value
Endogenous variable:							
AAC smoothing ratio	H > < NH	3.05	1.68	**Hedger**	**0.00**	**1.86**	**0.00**
Common explanatory variables:							
Explrisk	H > NH	0.01	0.00	**Hedger**	**0.00**	**1.57**	**0.06**
FullCost	H > < NH	0	0	Non-hedger	0.91	−0.11	0.91
Leverage	H > NH	0.32	0.14	**Hedger**	**0.00**	**2.89**	**0.00**
M/B	H > NH	1.30	1.31	Non-hedger	0.45	1.42	0.92
Tax	H > NH	0	0	Hedger	0.15	1.01	0.15
MgrlOwn (percent)	H > < NH	8.23	7.51	Non-hedger	0.57	0.76	0.44
Stock options	H < NH	0.04	0.03	Hedger	0.35	−1.12	0.87
InstitOwn (percent)	H > < NH	51.67	3.48	**Hedger**	**0.00**	**8.04**	**0.00**
Firm size	H > NH	5.16	3.31	**Hedger**	**0.00**	**4.21**	**0.00**
Variables for hedging equations:							
σRET	H < NH	0.09	0.11	**Non-hedger**	**0.00**	**−3.17**	**0.00**
Production exposed (percent)	H < NH	6	2	Hedger	0.23	−0.32	0.63
Intl production	H < NH	0	0	Hedger	0.47	0.37	0.47
O&G Production (percent)	H > NH	98	100	Non-hedger	0.11	0.04	0.52
Cash	H < NH	0.03	0.06	**Non-hedger**	**0.00**	**−3.17**	**0.00**
Variables for AAC smoothing equation:							
DivPayout	H > < NH	0	0	Hedger	0.03	0.51	0.60
MarkToMarket	H > < NH	0	0	**Hedger**	**0.00**	**2.44**	**0.00**

(*Continued on next page*)

TABLE 2 (Continued)

Panel C: For the Sample of Firm-Years with Hedging, Differences between Full Cost (n = 55 firm years) and Successful Efforts (n = 48 firm years)[c]

	Medians		Wilcoxon Rank Sum Test		t-test of Difference in Means	
Variable	*FC Firm*	*SE Firm*	*Higher Score*	*p-value*[d]	*t-statistic*	*p-value*
Endogenous variables:						
AAC smoothing ratio	6.13	2.68	**FC firm**	**0.00**	**2.66**	**0.00**
Hedging ratio	0.27	0.26	FC firm	0.79	−0.09	0.92
Common explanatory variables:						
Explrisk	0.01	0.00	FC firm	0.23	1.21	0.22
Leverage	0.28	0.37	**SE firm**	**0.04**	**−1.86**	**0.06**
M/B	1.35	1.26	SE firm	0.75	−0.94	0.38
Tax	0	0	SE firm	0.71	−0.37	0.70
MgrlOwn	14.47	7.85	FC firm	0.32	0.47	0.63
Stock option	0.05	0.04	**FC firm**	**0.05**	**2.34**	**0.02**
InstitOwn	58.46	51.67	FC firm	0.89	0.24	0.81
Firm size	5.08	5.38	SE firm	0.22	−1.47	0.14
Variables for hedging equations:						
σRET	0.10	0.09	FC firm	0.05	1.24	0.21
Production exposed	10.50	4.81	**FC firm**	**0.07**	**2.24**	**0.01**
Intl production	0	0	SE firm	0.53	−0.61	0.54
O&G Production	100	91.85	**FC firm**	**0.03**	**2.03**	**0.04**
Cash	0.04	0.03	FC firm	0.92	−1.05	0.29
Variables for AAC smoothing equation:						
DivPayout	0	0	SE firm	0.00	0.24	0.81
MarkToMarket	0	0	SE firm	0.25	−1.12	0.26

[a] Hypothesized sign is based on the discussion in Section III for Equations (1)–(3). Where there is no prediction for a variable regarding the hedge/no hedge decision, we include the variable for completeness.
[b] p-values are one-tailed if there is a directional prediction; two-tailed otherwise.
[c] No predictions were developed for full cost and successful efforts methods in the full sample.
[d] p-values are two-tailed.
Coefficients are in **bold** print if in the hypothesized direction when both the t-test and Wilcoxon tests are significant at $p < 0.10$.
See Table 1 for variable definitions.

M/B (coefficient of variation = 3.48), and firms are leveraged to a considerable degree (mean *Leverage* = 0.42, median = 0.24). Fifteen percent of firm-years have an NOL carryforward and are profitable. Institutional investors own approximately 30 percent of the shares of our sample firms, whereas managers hold, on average, 19 percent (median = 7.5 percent) of their firms' shares and have exercisable options for an additional 7 percent (median = 4 percent). The mean market value of equity in the sample is $522 million, which is substantially greater than the median of $65 million. This skewness prompts us to use the log of market value of equity as our *Firm size* variable in the subsequent empirical analysis.[11]

Of the variables that are likely determinants of hedging alone, average variability of returns (σRET) is approximately 12 percent per firm-year. The mean level of *Production exposed* to basis risk is 24 percent, while 36 percent of firm-years reflect production at international locations. There is little diversification of operations, since the mean *O&G Production* is 89 percent and the median is 100 percent. *Cash* availability averages 0.11 (median = 0.05) of the market value of equity.

As for explanatory variables identified as determinants only of smoothing with AACs, in most firm-years managers pay no dividends, but there are a few cases of very large *DivPayout* values.[12] Managers use derivatives for trading purposes in only 7 percent of firm-years.[13]

Univariate Results

For descriptive purposes, we present univariate comparisons of two partitions of the sample in Panels B and C of Table 2, using one-tailed tests of differences where we have a directional prediction, and two-tailed tests otherwise. In Panel B, we compare the 103 sample firm-years with hedging to the 133 firm-years without hedging. Larger and highly leveraged firms are more likely to hedge, as are firms for which institutions hold a relatively high proportion of the firm's shares. Hedgers on average have lower levels of both *Cash* and σRET. Hedging is also associated with higher average levels of both exploration risk and smoothing with AACs. Untabulated results reveal that the Spearman correlation between *Hedging ratio* and *AAC smoothing ratio* for the full sample is significantly positive ($\rho_s = 0.138$; $p = 0.02$), suggesting that firms use both hedging and smoothing with AACs to manage volatility. However, within the sample of 103 firm-years with hedging, we find negative correlations between *Hedging ratio* and *AAC smoothing ratio* (Pearson = −0.18, p = 0.07; Spearman = −0.12, p = 0.10), consistent with managers who do decide to hedge using these smoothing mechanisms as substitutes. These univariate results suggest that the decision to hedge is associated with a greater level of smoothing with abnormal accruals, but that once the firm decides to hedge, the amount hedged is inversely related to the amount of smoothing with abnormal accruals, consistent with a trade-off at the margin. Our simultaneous equation design allows for substitutions between these two smoothing tools at the margin and controls for factors that affect cross-sectional differences in incentives for smoothing.

Our other univariate comparison divides the 103 hedging firm-years into full cost and successful efforts usage (see Table 2, Panel C). Full cost is associated with lower leverage, greater managerial holdings of stock options, greater exposure to basis risk, less diversified

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[11] Other variables also reflect skewness. We re-run all regressions after down-weighting influential observations (Belsley et al. 1980) using the RWEIGHT function in SAS. Our primary inferences are unaffected.

[12] Our inferences are unchanged when we use log of 1 + *DivPayout*.

[13] About 40 percent of sample firms' shares trade on the NYSE, and the Big 6 audit 81 percent of the firm-years.

operations, and higher levels of smoothing with AACs. Similar to Geczy et al. (1999), we find no relation between the extent of hedging and the choice of full cost or successful efforts.

Few correlations between variables (in the full sample and in the subset of firm-years with hedging) exceed 0.30 (not shown). Not surprisingly, two exceptions are that the correlation between *M/B* and *M/B* × *Leverage* is 0.94, and the correlation between the log of firm size and *InstitOwn* is 0.60. In our empirical analysis we estimate alternative models that, in turn, include and exclude highly correlated variables to address concerns about potential problems due to multicollinearity.

Results of Primary Hypothesis Tests

Our primary results are based on the analysis presented in Table 3. We initially estimate a binomial probit model to identify the determinants of the decision of whether to hedge, and to extract the inverse Mills ratio. We then use 2SLS in the sample of firm-years in which hedging occurs. We determine predicted values of the endogenous variables and include them along with the exogenous variables and the inverse Mills ratio in second-stage regressions. We report one-tailed p-values unless the prediction is nondirectional.

The results of the hedge/no hedge (1/0) probit appear under the heading of *Hedgers*. The positive coefficient on *Explrisk* ($p = 0.10$) indicates that firms with more exploration risk are more likely to hedge. *M/B* × *Leverage* has a significantly positive coefficient, consistent with a higher probability of hedging the greater the costs of underinvestment, as reflected in the interaction between growth opportunities and debt financing. Contrary to expectations, the coefficient on *M/B* is negative. The high correlation between the two growth-opportunities variables likely explains the unexpectedly opposite sign. Untabulated analyses reveal that when we exclude *M/B* × *Leverage* from the model, *M/B* is positive and significant as expected, consistent with hedging increasing with a firm's growth opportunities; in addition, *Leverage* becomes positive and significant as expected. The higher the level of institutional ownership, the more likely a firm is to hedge, consistent with managers responding to external pressures for predictable earnings by hedging oil price risk. The significantly positive *Firm size* coefficient is consistent with the importance of economies of scale in implementing a hedging program. Also as expected, the greater the basis risk due to international production, the lower the probability that oil and gas producers hedge.[14] Finally, the greater the proportion of sales from oil and gas production (i.e., the less diversified the operations), the higher the probability of hedging.

The two right-hand sets of columns in Table 3 report the results of the simultaneous equations estimation. Reported t-statistics are White (1980) adjusted. The coefficient on *PredAAC smoothing ratio* in the *Hedging ratio* regression is not significant ($t = 0.83$). On the other hand, the coefficient on *PredHedging ratio* in the *AAC smoothing ratio* regression is reliably negative, as predicted ($t = -2.41$). Thus, after controlling for other determinants of AAC smoothing, the more firms hedge oil price risk with derivatives, the lower the level of smoothing with AACs. The Hausman (1978) tests for simultaneity (bottom row of Table 3) are consistent with these results: We can reject the null hypothesis of no simultaneity

[14] *Intl production* might proxy for more than basis risk exposure. Firms with overseas oil and gas production may be subject to foreign exchange risk as well as basis risk. Although oil price is denominated in U.S. dollars worldwide, thus protecting revenues from foreign exchange risk, the cost side could be exposed. Thus, firms with international production may have an incentive to hedge foreign exchange risk, and our dummy variable could proxy for that. The observed negative coefficient on *Intl production* in the hedge/no hedge regression would then capture both the impediment to hedging oil price risk due to basis risk and substitution between foreign exchange hedging and oil price hedging.

TABLE 3
Results for Estimation of the Binomial Probit Model of the Decision to Hedge and the Subsequent Two-Stage Least Squares Estimation of the Extent of Hedging and the Extent of Smoothing with Abnormal Accruals

	Dependent Variables								
	Hedgers			*Hedging Ratio*			*AAC Smoothing Ratio*		
Independent Variables	*Expected Sign*	*Coeff.*	*χ^2 Value*	*Expected Sign*	*Coeff.*	*t-statistic*	*Expected Sign*	*Coeff*	*t-statistic*
Intercept	?	−1.87	5.24**	?	2.28	0.80	?	−5.57	−1.32
Endogenous variables:									
PredAAC smoothing ratio				−	0.17	0.83			
PredHedging ratio							−	−4.30	−2.41***
Common explanatory variables:									
Explrisk	+	0.33	1.79*	+	−0.37	−0.43	+	−5.83	−1.02
FullCost	+/−	−0.00	0.00	+/−	−0.32	−0.57	+/−	2.32	2.07**
Leverage	+	−0.88	1.26	+	−0.67	−0.90	+	−5.28	−1.43
M/B	+	−0.68	16.31	+	−0.07	−0.32	+	1.11	1.40*
M/B × Leverage	+	0.78	12.51***	+	0.07	0.25	+	1.36	1.87**
Tax	+	−0.35	0.89	+	0.32	1.91**	+	−0.48	−0.40
MgrlOwn	+/−	0.01	1.67	+/−	0.01	2.43***	+/−	0.07	3.06**
Stock options	−	−0.69	0.42	−	−2.63	−1.43*	−	1.09	0.47
InstitOwn	+/−	0.02	9.96***	+/−	−0.00	−2.47***	+/−	0.04	1.74*
Firm size	+	0.31	10.74***	+	0.15	0.65	+/−	1.19	2.73**
Variables for hedging equations:									
σRET	−	−2.97	1.37	−	0.48	1.20			
Production exposed	−	−0.00	0.00	−	−0.01	−1.30*			
Intl production	−	−0.81	9.56***	−	−0.21	−0.59			
O&G Production	+	0.01	2.48*	+	0.01	1.69**			
Cash	−	−1.07	0.98	−	−1.94	−0.89			

(*Continued on next page*)

TABLE 3 (Continued)

	Dependent Variables								
	Hedgers			*Hedging Ratio*			*AAC Smoothing Ratio*		
Independent Variables	*Expected Sign*	*Coeff.*	*χ^2 Value*	*Expected Sign*	*Coeff.*	*t-statistic*	*Expected Sign*	*Coeff*	*t-statistic*
Variables for AAC smoothing equations:									
DivPayout							+	0.06	2.45**
MarkToMarket							+	−1.71	−1.19
InvMills				?	−0.04	−0.41	?	6.27	3.12**
Number of observations			236			103			103
OLS adjusted R^2			30.22%						
Second-stage OLS adjusted R^2						15.85%			19.93%
Hausman simultaneity test: p-value						0.46			0.00

*, **, *** Indicate p-values less than or equal to 0.10, 0.05, 0.01, respectively. p-values are one-tailed if the coefficient is significant in the hypothesized direction, and two-tailed otherwise; t-statistics are White (1980)-adjusted in the *Hedging ratio* and *AAC smoothing ratio* regressions. An OLS adjusted R^2 is provided for the probit regression for descriptive purposes. Coefficients on year-dummies are not reported.

PredAAC smoothing ratio and *PredHedging ratio* are predicted values of the respective endogenous variables derived from the first-stage of two-stage least squares estimation. *InvMills* is the inverse Mills ratio extracted from the *Hedgers* regression. We assume the decision to hedge is independent of the extent of smoothing with abnormal accruals.

See Table 1 for other variable definitions.

for the *AAC smoothing ratio* regression (p = 0.00) but not for the *Hedging ratio* regression. Collectively, these results suggest that oil and gas producers determine the extent of hedging independently of their decisions about smoothing with AACs, but that the extent to which they smooth with AACs is inversely related to the amount they hedged, after controlling for other determinants of smoothing.

Our inferences differ from those in Barton (2001), who finds evidence of simultaneity and substitution between hedging and AACs in both his derivatives and accruals regressions. However, in a sensitivity test, Barton (2001, 21) detects some evidence of sequentiality, consistent with our inference that managers first determine the extent of hedging with derivatives, and then manage residual volatility by trading off smoothing with AACs against hedging. Barton's (2001) sample differs from ours; it covers the period 1994–1996, it is a much larger and broader sample that includes large firms from many industries, 72 percent of his sample use derivatives for foreign exchange and interest rate hedging, and he does not consider commodity derivatives. Possible reasons why Barton (2001) found that the extent of abnormal accruals affects hedging while we did not include the following: (1) because of his broad-based sample spanning many industries, Barton's AAC and derivatives variables are likely noisier than our industry-specific measures, and measurement error is an alternative explanation for his result (see Barton 2001, 3–4, 8, 21; Greene 1993, sections 9.5.5 and 20.5); (2) our smaller sample may provide less powerful tests; and (3) non-oil and gas firms that face interest rate risk associated with long-term debt likely take hedging positions less frequently than firms hedging oil price risk, because derivatives that hedge such interest rate risk typically are in place for longer periods of time than are commodity derivatives that hedge oil price risk. If managers of non-oil and gas firms hedge less frequently and therefore use accruals more frequently to manage residual volatility, then these managers may be more likely to consider their accrual decisions in taking derivative positions. We leave the resolution of the difference in the two studies' inferences for future research.

In the *Hedging ratio* regression, several control variables are significant. There tends to be more extensive hedging in years when firms are profitable and have NOL carryforwards (t = 1.91), consistent with Graham and Smith (1999). Managers holding higher percentages of their firms' outstanding shares hedge more (t = 2.43), perhaps because they are risk-averse and either unable to diversify firm-specific risks or wish to make their firms appear less risky. There is weak support for less hedging the more stock options that managers hold (t = −1.43), whereas there is more extensive hedging the lower the level of institutional holdings (t = −2.47). To the extent that lower institutional ownership proxies for less external monitoring, managers may hedge to help external parties gauge profitability due to managerial performance.[15] There also tends to be less hedging the more production exposed to basis risk (t = −1.30), and more hedging in firm-years with less diversified operations (t = 1.69), consistent with Haushalter (2000). Also consistent with Haushalter (2000), *Firm size* is significant in the hedge/no hedge regression, but not in the extent of hedging regression.

Turning to the *AAC smoothing ratio* regression, in addition to the negative coefficient on *PredHedging ratio*, there are several other significant determinants of AAC smoothing. Full cost firms use AACs to smooth earnings more extensively than do successful efforts firms (t = 2.07), suggesting that unidentified factors beyond those controlled here prompt

[15] The significantly negative coefficient on *InstitOwn* is likely not due to collinearity with firm size. In untabulated results using firm-years with hedging, we find significantly lower mean and median *InstitOwn* in firm-years with more extensive hedging.

full cost firms to smooth earnings even more, beyond the smoothing effects of the full cost method.[16] There is more smoothing with AACs in firm-years with larger growth opportunities (t = 1.40) and greater costs of underinvestment (t = 1.87). Dropping *M/B* × *Leverage* from the *Hedging ratio* and *AAC smoothing ratio* equations does not result in *Leverage* becoming significant, in contrast to the *Hedgers* regression results. Consistent with the *Hedging ratio* regression results, the greater the managerial ownership, the more smoothing, in this case with AACs (t = 3.06). However, contrary to the results for the *Hedging ratio* regression, higher levels of institutional holdings are associated with greater smoothing with AACs (t = 1.74), suggesting that external pressures may induce managers to use AACs to make reported earnings more predictable. Finally, smoothing with AACs increases with *Firm size* (t = 2.73) and with higher dividend payout rates (t = 2.45).

Somewhat surprisingly, the results suggest that the level of exploration risk is an important determinant only of the decision to hedge. That is, the higher the level of exploration risk, the more likely managers are to hedge, but the level of exploration risk does not play a significant role in managers' decisions about the extent of hedging or smoothing with AACs.

On the whole, the significance of the results for the control variables in both the hedging and smoothing with accruals regressions are mixed and weak. However, the predicted control variables are not the key hypothesized effects. To better isolate the core effects of hedging on smoothing with AACs and vice versa, we opted to control for factors that might possibly be associated with hedging or smoothing with AACs, even if the rationale for including a control variable was not beyond question. Moreover, we based our predictions for the control variables on expected unconditional relations between the control variables and the extent of smoothing with AACs or hedging. The incremental effect of each control variable, conditional on the inclusion of all other variables in the regressions, may not be the same as the predicted unconditional relation. Our small sample size also likely contributed to some of the control variables' insignificant results.

We tested the null hypothesis that the proportion of significant coefficients in each of the regressions in Table 3 is not greater than the proportion that would be expected by chance. Specifically, we treated the *Hedgers, Hedging ratio,* and *AAC smoothing ratio* regressions separately, related the number of coefficients that are significant in the predicted direction to the total number of coefficients with directional predictions, and then used a binomial test of the difference in proportions to investigate whether significantly more than 10 percent of the coefficients in each equation are significant in the predicted direction.[17] In untabulated results, we can reject the null hypothesis at the 0.03 level or better for each of the three regressions. This analysis supports the conclusion that the reported results are not likely a chance occurrence, although it is clear that we need further research to identify more definitively the determinants of income smoothing using AACs or hedging.

Finally, in the *AAC smoothing ratio* regression, the coefficient on the inverse Mills ratio (the selectivity term that measures the covariance between the decisions about whether to hedge and the extent of smoothing with AACs) is positive and significant (t = 3.12). Hence, firms that opt to hedge are more likely to smooth with AACs (Heckman 1979; Shehata 1991). Coupled with our primary results, this suggests that although firms that hedge are

[16] Incorporating *FullCost* in the modified Jones model should mitigate any mechanical tendency of full cost to induce larger *AAC smoothing ratio* values.

[17] The test statistic is $(\hat{p} - p_0)/\sqrt{p_0(1 - p_0)/n}$, where $\hat{p}$ is the observed proportion of significant coefficients, p_0 is the null hypothesis proportion (0.10), and n is the total number of coefficients with directional predictions (excluding the intercept and the inverse Mills ratio). We evaluate the significance of the test statistic using a t distribution.

more likely to smooth with AACs, the extent to which they use AACs to smooth earnings is inversely related to the extent they hedge, consistent with trade-offs at the margin by managers using both smoothing tools.[18]

Evidence on the Sequential Process

The negative coefficient on the hedging ratio in the *AAC smoothing ratio* regression and the insignificant coefficient on the smoothing ratio in the *Hedging ratio* regression in Table 3 are consistent with managers first deciding whether and how much to hedge, and then substituting between abnormal accruals and hedging to manage residual earnings volatility. If this sequential decision process is valid, then we would expect more of the abnormal accrual vs. hedging trade-off to occur in the fiscal fourth quarter than in the first three fiscal quarters. By the fourth quarter, managers have more accurate information about likely residual earnings volatility, and can make AAC decisions accordingly. Hence, we focus on the effects of the fourth quarter vis-à-vis the first three fiscal quarters to provide more direct evidence on the sequential process.

We recompute the dependent variable in the *AAC smoothing ratio* equation using data from fiscal quarters 1–3 and also obtain a new predicted AAC smoothing variable for the *Hedging ratio* equation; all other variables remain unchanged. The mean *AAC smoothing ratio* before deleting the fourth quarter data is 4.20, as reported in Panel A of Table 2. However, the mean ratio increases to 4.85 when we delete fourth-quarter data, and the difference in means is significant at the 0.07 level. Thus, there is more smoothing in the first three quarters than in the fourth quarter. This is consistent with managers making fiscal fourth quarter adjustments that ''settle up'' errors in interim quarters' accruals (Collins et al. 1984; Mendenhall and Nichols 1988; see also Palepu 1988) and also with more nonrecurring transactions occurring in the fourth quarter (Elliott and Shaw 1988).

We next test whether our substitution hypothesis holds after deleting fiscal fourth quarter data to compute the AAC smoothing variables. We re-estimate Equations (1)–(3) and obtain the following results (see Panel A of Table 4): (1) In the *Hedging ratio* equation, both the coefficient on *PredAAC smoothing ratio* and the Hausman simultaneity test are insignificant, as in Table 3, but (2) in the *AAC smoothing ratio* equation, the negative relation between the extent of smoothing with AACs and hedging becomes insignificant, as does the Hausman test. Thus, there is no evidence that managers substitute between the extent of hedging and smoothing with AACs in the first three quarters of the year. Consequently, this substitution appears to arise largely in the fourth quarter. This pattern of evidence is consistent with a sequential decision-making process where managers first hedge and then, mostly in the fourth quarter, trade off the use of AACs and hedging with derivatives to manage residual volatility in income.

We extend the analysis by deleting data from the first quarter instead of the fourth quarter. If the sequential process is valid, then we expect that by including fourth-quarter data the coefficient on *PredHedging ratio* will again be significantly negative in the *AAC smoothing ratio* regression, as in Table 3, and the Hausman simultaneity test will also be significant. The results confirm this expectation: the coefficient on the hedging ratio is

[18] We re-estimated the *Hedging ratio* and *AAC smoothing ratio* regressions separately using OLS, and the results are similar to those reported in Table 3. In addition, we tested for serial correlation in the residuals because some firms contribute more than one observation to our sample. For the *AAC smoothing ratio* regression, the Durbin-Watson statistic is 2.06, indicating no first-order serial correlation. For the *Hedging ratio* regression, Durbin-Watson = 1.29 (p = 0.05). Understatement of the standard error from the indicated serial correlation is not a serious concern, however, because the coefficient on *AAC smoothing ratio* is insignificant.

TABLE 4
Two-Stage Least Squares Estimation of the Extent of Hedging and the Extent of Smoothing with Abnormal Accruals after Excluding One Fiscal Quarter's Data in Calculating *AAC Smoothing Ratio* and *PredAAC Smoothing Ratio*, Leaving All Other Variables Unchanged

Panel A: Excluding Data from the Fiscal Fourth Quarter in Computing the AAC Smoothing Ratio[a]

	Dependent Variables					
	Hedging Ratio			*AAC Smoothing Ratio*		
Independent variables	*Expected Sign*	*Coeff.*	*t-statistic*	*Expected Sign*	*Coeff.*	*t-statistic*
Intercept	?	1.42	0.90	?	−2.45	−0.47
Endogenous variables:						
PredAAC smoothing ratio	−	0.11	1.05			
PredHedging ratio				−	−5.40	−0.90
Common explanatory variables:						
Explrisk	+	0.81	1.13	+	−2.72	−0.59
FullCost	+/−	−0.18	−0.56	+/−	2.17	1.75*
Leverage	+	0.76	1.32	+	−6.04	−1.37
M/B	+	0.07	0.31	+	−1.07	−1.23
M/B × Leverage	+	−0.07	−0.29	+	1.11	1.09
Tax	+	0.49	1.89**	+	−2.46	−1.74
MgrlOwn	+/−	−0.01	−0.56	+/−	0.08	2.81***
Stock options	−	−1.78	−1.89**	−	−7.47	−0.84
InstitOwn	+/−	−0.00	−0.60	+/−	0.05	1.80**
Firm size	+	−0.09	−0.66	+/−	1.03	1.97**
Variables for hedging equations:						
σRET	−	6.47	1.96			
Production exposed	−	−0.01	−1.89**			
Intl production	−	−0.04	−0.16			
O&G Production	+	0.00	0.65			
Cash	−	−0.42	−0.44			
Variables for AAC smoothing equations:						
DivPayout				+	0.07	2.52**
MarkToMarket				+	−4.39	−2.52
InvMills	?	−0.44	−0.51	?	6.23	2.57**
Number of observations		103			103	
Second-stage OLS adjusted R^2			10.45%			14.33%
Hausman simultaneity test: p-value			0.65			0.45

(*Continued on next page*)

TABLE 4 (Continued)

Panel B: Excluding Data from the Fiscal First Quarter in Computing the AAC Smoothing Ratio[b]

	Dependent Variables					
	Hedging Ratio			AAC Smoothing Ratio		
Independent variables	*Expected Sign*	*Coeff.*	*t-statistic*	*Expected Sign*	*Coeff.*	*t-statistic*
Intercept	?	3.22	0.69	?	−2.27	−0.50
Endogenous variables:						
PredAAC smoothing ratio	−	0.39	0.40			
PredHedging ratio				−	−3.99	−1.83**
Common explanatory variables:						
Explrisk	+	0.62	0.72	+	−1.98	−0.48
FullCost	+/−	0.65	0.33	+/−	2.03	1.83*
Leverage	+	1.41	0.62	+	−2.61	−0.66
M/B	+	−0.36	−0.42	+	−0.44	−0.57
M/B × *Leverage*	+	0.40	0.06	+	0.54	0.59
Tax	+	0.04	0.95	+	0.50	0.40
MgrlOwn	+/−	−0.01	−0.26	+/−	0.04	1.81*
Stock options	−	−4.31	−1.64*	−	1.25	0.16
InstitOwn	+/−	−0.01	−0.32	+/−	0.06	2.13**
Firm size	+	−0.02	−0.08	+/−	0.41	0.89
Variables for hedging equations:						
σ*RET*	−	6.04	1.84			
Production exposed	−	−0.01	−1.91**			
Intl production	−	−0.73	−0.43			
O&G Production	+	0.02	0.35			
Cash	−	−0.70	−0.81			
Variables for AAC smoothing equations:						
DivPayout				+	0.05	1.87*
MarkToMarket				+	−1.99	−1.28
InvMills	?	0.83	0.26	?	5.38	2.47**
Number of observations			103			103
Second-stage OLS adjusted R^2			8.43%			11.12%
Hausman simultaneity test: p-value			0.47			0.02

*, **, *** Indicate p-values less than or equal to 0.10, 0.05, 0.01, respectively. p-values are one-tailed if the coefficient is significant in the hypothesized direction, and two-tailed otherwise; t-statistics are White (1980)-adjusted in the *Hedging ratio* and *AAC smoothing ratio* regressions.

Coefficients on year-dummies are not reported.

[a] *AAC smoothing ratio* is computed using data from fiscal quarters 1–3, and *PredAAC smoothing ratio* is derived from the first stage of two-stage least squares estimated based on the recalculated *AAC smoothing ratio.*

[b] *AAC smoothing ratio* is computed using data from fiscal quarters 2–4, and *PredAAC smoothing ratio* is derived from the first stage of two-stage least squares estimation based on the recalculated *AAC smoothing ratio*.

Results for the *Hedgers* regression are unaffected and not repeated here (see Table 3).

All other variables are as defined in Table 3 and Table 1.

significantly negative (t = −1.83) and the Hausman test is significant (p = 0.02; see Panel B of Table 4). Thus, the primary results remain when we drop first-quarter data, but not when we drop fourth-quarter data.

Control variables with significant coefficients in the *AAC smoothing ratio* regression in Table 3 remain significant in Table 4 except for (1) *M/B* and *M/B* × *Leverage,* when we drop fourth-quarter data, and (2) *M/B, M/B* × *Leverage,* and *Firm size*, when we drop first-quarter data. In the *Hedging ratio* equation, (1) *Tax, Stock options,* and *Production exposed* continue to have significant coefficients, as in Table 3, even after we drop fourth-quarter data, but *MglrOwn, InstitOwn,* and *O&G Production* do not, and (2) we obtain similar results when we drop first-quarter data, except *Tax* is no longer significant.

The regressions in Table 4 reflect lower explanatory power than those in Table 3, and we cannot reject the null hypothesis that the proportion of significant coefficients with directional predictions is what we would expect by chance (not shown).[19] The lower explanatory power may be due to time-period misalignment, because we use three fiscal quarters to estimate smoothing-with-AACs variables vs. annual data for all other variables. The lack of availability of quarterly data on derivatives precludes us from computing *Hedging ratio* based on three fiscal quarters' data instead of annual data. The differences in the control variable results between Panels A and B of Table 4 stem from the calculation of the AAC smoothing variables. We compute the AAC smoothing variables using data from quarters 1–3 in Panel A vs. data from quarters 2–4 in Panel B. As noted above, fiscal fourth quarters typically reflect accruals that correct estimation errors from interim quarters (e.g., inventory estimates vs. actual counts) and there may also be more nonrecurring events in the fourth quarter. Thus, computing the AAC smoothing variables using data from the first three quarters should affect the smoothing variables differentially as compared to the case where we compute them using data from quarters 2–4, and, in turn, the relations of these alternatively computed smoothing variables with the control variables in the regressions should also be differentially affected.

Additional Robustness Checks

Finally, we report on a series of tests performed to assess further the sensitivity of the results (details not shown). First, we redefined the denominator of *Hedging ratio* as oil and gas production plus reserves to allow for the possibility that oil price risk extends to reserves. We re-ran the analysis and our inferences are unaffected.

Second, we re-ran the analysis after (1) augmenting Equations (1)–(3) with variables reflecting the interaction of *FullCost* with *PredAAC smoothing ratio, Explrisk,* and other control variables that rely on accounting measures and that are thus likely to be systematically affected by the choice of full cost or successful efforts, and (2) including *M/B* or *M/B* × *Leverage,* but not both, in the models because these variables are highly correlated in the hedge/no hedge regression. Our inferences are unchanged under these alternative model specifications.

Third, Collins and Hribar (2000) identify measurement error in estimating abnormal accruals using changes in balance sheet data instead of cash flow statement data. The problem arises primarily in periods when major acquisitions or divestitures occur. We identified 20 firms for which any sample quarter was affected by a merger or discontinued operations. We eliminated these firms and re-estimated the *AAC smoothing ratio*. The resultant smoothing ratio is insignificantly higher than the full-sample ratio (4.46 vs. 4.20),

[19] We can reject the null hypothesis of chance for the AAC smoothing regressions when we consider both one-tail and two-tail predictions.

and we obtain qualitatively similar results when we re-run the analysis using the re-estimated *AAC smoothing ratio*.

Fourth, we adjust for special items in the *AAC smoothing ratio* calculation. We obtain special items data for all firm-quarters from Compustat (quarterly data item #32), tax-adjust the data (multiplying by 1 − tax rate, or 0.65), and purge the resulting loss or gain from cash flows from operations. The mean *AAC smoothing ratio* becomes 4.21 vs. 4.20 before such adjustment, the difference between the two ratios is not significant, and our inferences are unaffected when we re-run our primary analysis using the adjusted *AAC smoothing ratio*.[20]

V. SUMMARY AND CONCLUSIONS

We examine whether managers use abnormal accrual choices and oil and gas price hedging with derivatives as substitute mechanisms to manage earnings volatility. Our goal is to investigate how accounting decisions affect hedging, and vice versa. Firms engaged in oil and gas exploration and drilling face two kinds of inherent risks that induce volatility in their earnings streams. Firms can hedge oil price risk with derivative instruments, but markets do not exist in which firms can hedge the operational risk of unsuccessful drilling. Firms can, however, use both hedging and abnormal accruals to dampen the impact that oil price and exploration risks have on earnings variability. We find that once managers of oil and gas producing firms decide to hedge, they trade off the extent of smoothing with abnormal accruals against the extent of hedging, at the margin. More specifically, the results suggest that managers of oil and gas producing firms take commodity hedging positions independent of their decisions about abnormal accruals, but then, primarily in the fourth quarter, substitute between abnormal accruals and hedging with derivatives to manage residual volatility.

There are several limitations of our study. First, we have data only on year-end derivative positions and thus cannot gauge derivative activity throughout the year. Second, our smoothing-with-AACs variable captures managerial discretion with measurement error. Third, we have not treated the full cost vs. successful efforts accounting choice as an endogenous element of a firm's overall strategy for managing earnings volatility, although we incorporate the choice when estimating abnormal accruals and also as a determinant of hedging and smoothing with abnormal accruals. Fourth, our conclusion that a sequential hedging-then-abnormal-accruals decision process characterizes oil and gas managers' behavior contrasts with Barton's (2001) overall conclusion of a simultaneous process whereby abnormal accruals affect hedging, as well as hedging affecting abnormal accruals. We are not able to resolve the differences between our inferences and those in Barton (2001), and leave that task for future research. Finally, our results may not generalize to other populations because of our single-industry oil and gas producer setting, and because our data requirements bias the sample toward larger producing firms that are income smoothers.

[20] We also examined firms' financial reports for special items, and they typically reflect activities related to oil and gas exploration and production. These include (1) provisions for dismantlement, restoration, and reclamation based on estimates of, for example, environmental clean ups, and (2) provisions for asset impairments, including write-downs of oil and gas properties. There are more frequent and larger-magnitude oil and gas reserve write-downs in firm-years with hedging vs. those with no hedging, but a few extreme impairments reported in October 1995 under SFAS No. 121 (FASB 1995) primarily drive the magnitude difference.

APPENDIX A
Illustration of the Computation of the Hedging Ratio from SFAS No. 69 Disclosures and Commodity Derivative Disclosures from the 1995 Form 10-K of Newfield Exploration Company

I. SFAS No. 69 Disclosures

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
Production	(2,071)	(33,719)
Other reserve changes during the year (details suppressed)	3,094	83,332
December 31, 1995	9,633	203,580

Reserve Quantities:

For the year ended December 31, 1995, quantity of proven oil reserves is 9.63 million barrels. Proven gas reserves of 203,580 million cubic feet, converted at the rate of 9,840 cubic feet to a barrel of oil (based on the ratio of average sale prices for oil and gas realized by the firm during 1995) is equivalent to 20.68 million barrels. Hence, the total reserves of the firm are 30.31 million barrels.

II. Derivative Disclosures (Voluntary Disclosures as per SFAS No. 119)

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.

	MMcf	*Period*	*Weighted Average Price (MMBtu)*	*Weighted Average Price (Mcf)*	*Fair Market Value*
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 period 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.

III. Our Study's Use of Derivative Disclosures to Compute the Hedge Ratio

1. Notional quantity of oil derivatives-short is the sum of

Oil swaps: 1,000 barrels/day for 180 days	0.182 million barrels
LLS contracts: 421 barrels/day for 120 days	0.050 million barrels
	0.232 million barrels

2. Notional quantity of gas derivatives is 15,000 MMcf or 1.524 million barrels of oil when converted at 9,840 cubic feet to a barrel of oil. Conversion is based on the ratio of the average sale price for oil and gas the firm realized during 1995.
3. Total notional quantity of derivatives: 1.756 million barrels of oil.
4. Production for the year is 5.497 million barrels. The production quantity is computed as 2.071 million barrels of oil (see disclosures in part I above) and 3.426 million barrels equivalent to 33,719 MMcf of gas (converted to oil at the conversion rate used in no. 2, above).
4. The company's *Hedging ratio* for 1995 is the total notional quantity of derivatives scaled by the notional quantity of production: 1.756 million barrels/5.497 million barrels **= 31.94 percent**.

APPENDIX B

Derivation and Computation of Sunder's Variance of Cash Flows from Exploration

I. Summary of Sunder's (1976) Theoretical Derivation

Consider a firm that drills N exploratory wells each period. The probability of a successful strike (θ) is the same each period.[21] The nonrecoverable exploration cost of each well is c. Each successful well yields a net operating revenue of x per period for L periods starting the period after drilling takes place.

S, the number of wells drilled in period t, is a random variable with a binomial distribution and parameters θ and N. The probability *(Pr)* that S equals an integer r between zero and N is given by: $Pr\ (S = r|\theta,N) = [N!/(N - r)!r!] \times [\theta^r(1 - \theta)^{N-r}]$. The expected value and variance of S are $N\theta$ and $N\theta(1 - \theta)$, respectively.

Revenue generated by drilling efforts is also a random variable. If S wells are successful, then this will yield operating revenues of Sx for L future periods beginning the next period, where x is the net operating cash flow per successful exploratory well per period for L periods. Therefore, the net future cash inflow in period t, X_t, will be: $X_t = -Nc + x\ (S_{t-1} + S_{t-2} + ... + S_{t-L})$. The mean of future net cash flows is $-Nc + xLN\theta$ and the variance is as follows:

[21] Assuming a constant θ implies that θ and N are independent. One can argue that θ depends on experience in previous periods (e.g., learning effects) or that θ is inversely related to N (e.g., firms probably exhaust better drilling prospects first). Because the components of our empirical measure of Sunder's variance can vary each year, we allow for the possibility that θ changes over time.

$$Var\ (X) = x^2 LN\theta(1 - \theta) = PV^2(1 - \theta)/LN\theta \tag{B1}$$

where *PV* is the present value of discoveries from exploration activity.[22]

Sunder (1976) does not indicate whether the parameters in Equation (B1) are to be estimated annually or as firm-level averages. We compute Sunder's variance annually because year-to-year differences in oil price levels can affect some of the parameters in Equation (B1). For example, the economic life of reserves and operating cash flows likely increase with oil prices.

II. Computing the Variance of Future Cash Flows from Exploration Activities

The following are excerpts of disclosures by Newfield Exploration Company for 1995 under SFAS No. 69. They represent the present value of discoveries from exploration activity; i.e., the changes in the standardized measure of discounted future net cash flows applicable to proved oil and gas reserves (in thousands of dollars):

	Year ended December 31, 1995
Beginning of the period	$180,002
Revisions of previous estimates:	
Additions to proved reserves resulting from extensions, discoveries and improved recovery, less related costs ($xLN\theta - Nc$)	87,760
Other reasons for the change (suppressed here)	8,564
End of period	$276,326

Based on the company's SFAS No. 69 disclosures for 1995, exploration costs (*Nc*) are \$32.50 million. Thus, $xLN\theta$, which equals $(xLN\theta - Nc) + Nc$, is \$87.76 + \$32.50 or \$120.26 million.

We now compute Sunder's variance using Newfield Exploration Company's 1995 data:

(a) Productive life of a well (L)

Using numbers drawn from part I of Appendix A, the productive life of a well is:
L = [(Beginning oil reserves/Oil production)+(Beginning gas reserves/Gas production)]/2 = [(8,610/2,071) + (153,967/33,719)]/2 = 4.362 years. (Our inferences are unchanged when we compute age as a weighted average of the ages of oil and gas wells instead of a simple average.)

(b) Number of exploratory wells drilled (N) and the success rate (θ)

The following table reports the company's drilling activity for 1995:

[22] Sunder's variance is unaffected by the choice of full cost or successful efforts, although it is affected by hedging, which affects cash flows. This likely reflects a second-order effect of the FC/SE choice on cash flows and hence on Sunder's variance. Exploration-related cash flows likely are measured before the impact of hedging, since we have not seen statements by sample firms that they hedge expected production from discoveries or exploration. They are more likely to hedge production from the extant stock of reserves.

	Gross[23]	*Net*
Exploratory wells:		
Productive	10	4.7
Nonproductive	6	3.9
Total	16	8.6

Number of exploratory wells *(N)* is 8.6 and success rate (θ) is 4.7/8.6 = 54.6 percent. Thus, 8.6 and 54.6 percent may be viewed as realizations from an underlying firm-specific distribution of N and θ. (If the number of exploratory wells drilled is 0 and/or the success rate is 0 or 1, then we set the variance equal to 0.)

(c) Present value of cash flows per productive period (x)

We compute x by dividing $xLN\theta$, the present value of discoveries from exploration activity, by [Productive life of a well *(L)* $\times$ Number of exploratory wells drilled *(N)* $\times$ Success rate (θ)] = $xLN\theta/LN\theta$ = \$120.26 million/(4.362 years $\times$ 8.6 wells $\times$ 0.546) = \$5.87 million.

(d) Variance of future cash flows from exploration activity

We compute the variance as $(xLN\theta) \times [x\,(1 - \theta)] = x^2LN\theta(1 - \theta)$ = \$120.26 million $\times$ [\$5.87 million $\times$ (1 − 0.546)] = \$320.49 million. Finally, we divide the variance of future cash flows from exploration activity by the value of year-end reserves, calculated as (quantity of year-end oil reserves $\times$ year-end spot price of oil) + (quantity of year-end gas reserves $\times$ year-end spot price of gas).

[23] Firms frequently conduct exploration activities as part of a consortium. A *gross well* is a well in which the firm owns an interest. A *net well* represents the fractional interest the firm owns in the gross well. We use net wells to compute exploration success.

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