Price information and earnings smoothing: Systematic evidence from the oil industry

Abstract

This paper studies the information that managers use to forecast earnings and implement earnings smoothing, investigating whether managers draw from a portfolio of different price information, available in the information environment, to smooth earnings. Using US oil firms quarterly data in the 1986-2019 period, the results show that, over the decades, oil firms systematically use accrual and real earnings management to decrease (increase) the income in quarters when the spot, the average and the expected future oil prices are high (low). The paper provides articulated and robust evidence of earnings smoothing, detailing the information used by managers and its economic relevance. The future price information has the same weight of the current price information in earnings smoothing decisions, revealing a complementary use. The paper adds earnings management literature, showing that the type of price information used by managers is key factor to analyze for understanding earnings smoothing decisions. Further, the paper provides evidence of whether the COVID-19 crisis has affected earnings smoothing Finally, differently by previous literature it shows that earnings management in the oil industry is a long-lasting activity not only related to specific and extraordinary events.

Keywords: earnings management, earnings smoothing, price information, oil industry, information environment

JEL codes: M41, Q02, E32

1. Introduction

Literature suggests that managers smooth income by using reporting discretion and operations to reduce the earnings volatility (Baik et al., 2020; Dechow et al., 2010). Studies also find that firms smoothing earnings have higher stock values and benefit from a lower cost of equity (Barth et al., 1999; Francis et al., 2005). Other studies suggest that managers smooth earnings to increase compensation, secure jobs (De Fond and Park, 1997) or get better trade terms with customers and suppliers (Dou et al., 2013; Graham et al., 2005). This stream of literature mainly investigated the determinants and the consequences of earnings smoothing, whilst the process and the type of information used by managers to smooth earnings are not yet thoroughly analyzed (Nelson and Skinner, 2013). This paper argues that analyzing the information used in earnings smoothing is necessary to advance the understanding of the firms' accounting choices.

To expand the understanding of this relevant topic, we investigate a portfolio of price information that managers may use to forecast earnings and implement smoothing activities. Opening this black box is interesting for two main reasons. Firstly, managers need a complete range of reliable information on the market and on the firm's operations to produce accurate and reliable earnings forecasts (Ittner and Michaels, 2017). From the managers' perspective, this information enables earnings smoothing without incurring in high costs. If managers believe the information used to project earnings is sufficiently reliable and accurate, they can engage in earnings smoothing without bearing excessive risks of potential misreporting, litigation or career damages (Desai et al., 2006; Schrand and Zechman, 2012). If managers believe that the information used to project earnings is not sufficiently accurate and reliable, they are not likely to engage in earnings smoothing, deeming it too risky. Recent studies addressed the effect of managerial ability in forecasting profits on earnings smoothing (Baik et al., 2020; Demerijan et al., 2020), while little is known on the relation between the information available to forecast earnings and smoothing decisions. Hence, analyzing the information used to smooth earnings is relevant because it relates to the management's assessment of the benefits/costs of accounting choices (Brennan, 2021; Baik et al., 2020; Gallemore and Labro, 2015).

Secondly, empirical analyses of the information underlying earnings smoothing only partially uncover which type of information managers use. Previous research suggested that the reliability and availability of information on the company's operations and economic prospects are crucial for earnings forecasts (Ittner and Michaels, 2017; Goodman et al., 2014;). However, there is still a lack of empirical evidence on the several types of information present in the information enviroment (e.g. price information, customer-related information, risk-related information, historical data, estimates of future trends) managers may use to forecast earnings and implement the earnings smoothing. It is relevant to address this topic, as it informs on the interaction between internal decision-making and external reporting (Brennan, 2021). Specifically, the paper focuses on price information. Price information indicates a set of information available that the managers may use to plan and forecast earnings, as well as to implement earnings management activities. Price information availability is a crucial component of the external information environment that managers can use for decision making (Shroff et al., 2014). Our research examines whether the quarterly spot price, the average quarterly price, the quarterly price volatility and the expected quarterly price are associated with earnings management and smoothing decisions.

The paper focuses on the oil industry. Oil commodity firms have volatile earnings that largely depend on commodity price information (Damodaran, 2009). The commodity price changes are a significant source of financial uncertainty to these companies (Poitras, 2013), as they are related to market and political factors beyond the control of management (Carter et al., 2017; Dayanandan and Donker, 2011; Dichev et al., 2013). Therefore, commodity firms' managers are interested in managing earnings volatility produced by the commodity price fluctuations to avoid potential financial losses (Barton, 2001; Pincus and Rajgopal, 2002). The commodity price volatility challenges the managers' ability to forecast earnings and may make earnings analyses complex and risky (Baik et al., 2020; Ittner and Michaels, 2017). Oil firms therefore represent a suitable setting to study the information underlying earnings smoothing and its use in the smoothing decisions. It enables to test the importance of the information environment available to the managers, when they are called to implement earnings smoothing activities. This research analyses the US oil industry's quarterly data from 1986 Q1 to 2019 Q4. The oil industry is one of the largest and most influential global commodity sectors (Crawford, 2021). The quarterly time series available in Compustat for US oil firms cover several decades and allows robust estimation of a potential presence of systematic earnings smoothing.

This study research design follows prior research on earnings management in oil firms (Byard et al., 2007; Han and Wang, 1998; Hsiao et al., 2016) and applies the recommendations by Chen et al. (2017) to include the explanatory variables in single equation earnings management models and avoid using residuals (i.e. discretionary/abnormal accruals/real) as dependent variables. To ensure robust evidence, we augment a battery of accrual and real earnings management models with oil price (Jones, 1991; Dechow et al., 1995; Kothari et al., 2005; Roychowdhury, 2006; Gilliam, 2021). Our paper also addresses endogeneity concerns by investigating the exogenous shock on the oil price caused by China's entry (as a member state) into the World Trade Organization (WTO). It also addresses other potential endogeneity concerns by using the dynamic panel method of moments model (Cascino, 2017).

The findings provide articulated and robust evidence that US oil firms systematically use income-decreasing (income-increasing) accrual earnings management in quarters when the quarterly spot oil price and the average quarterly price are high (low). This practice is used to shift profits across quarters and smooth quarterly earnings in response to oil price fluctuations. In quarters with high oil price volatility, oil firms engage in income-decreasing accrual earnings management. Further, the findings show that US oil firms use income-decreasing (income-increasing) accrual earnings management in response to the expected high (low) oil price in the subsequent quarters, measured with the future contracts' prices and with prices from a times series estimate. The time horizon of commodity price information used ranges from the closing quarter to the next three quarters. The oil price information links with earnings smoothing are economically significant. Our findings show that a 1% increase in the quarterly oil price (or in the expected future oil price) implies a decrease of the total accruals worth million $. The findings also provide evidence that price information is related to real earnings management. Managers use oil price to adjust inventory levels and increase (decrease) the costs of goods sold in quarter with high (low) price. Also, they use price information to increase (decrease) discretionary expenditures in quarters with high (low) oil price.

This paper contributes to prior earnings management literature. It provides articulated and robust evidence on which types of price information managers consider in earnings smoothing decisions. It adds to the literature on the influence of the information environment on forecasting earnings and earnings management (Devos et al., 2021; Demeriajn et al., 2020; Li and Zaiats, 2017). The findings suggest that using a portfolio of price information is an enabling factor of smoothing, allowing earnings forecasts and decreasing the costs of dampening earnings volatility for managers. The managers assess the oil price trend, combining past information and forecast information on the expected future price. The information on the future price appears to have the same weight of that on the current price in earnings smoothing decisions. The findings indicate that the magnitude of earning smoothing is economically relevant.

This study also contributes to earnings management literature with early evidence of the impact of Covid-19 on earnings management during the initial phase of the pandemic's global outbreak, thereby responding to previous research calls (De Vito and Gomez, 2020; Trombetta, 2020). Oil firms suspended earnings management during the first and second quarters of 2020. The market downturn was such that in April 2020, a negative oil price was reached for the first time in history. The analysis shows that earnings management ends because of market upheavals caused by Covid-19 crises. The managers' forecasting capability on future prices was barely possible due to the extreme uncertainty, thereby increasing the costs of quarterly earnings smoothing.

Finally, the paper extends the literature on earnings management in the oil industry, answering to a recent call to expand the research on earnings management in extractive industries (Gray et al., 2019). Previous studies find evidence of income-decreasing accruals in the quarter of oil price upward spikes, associated with politically sensitive events, like wars (Han and Wang, 1998), social uprisings (Hsiao et al., 2016) or natural disasters (Byard et al., 2007). According to these studies, earnings management is motivated by the fear of political costs. This paper shows that earnings management is not limited to quarters in which the oil firms' earnings are politically sensitive, but it is an ongoing and constant activity, by at least three decades, related to the oil price trend.

The remainder of the paper is organized as follows. Section 2 reviews the literature, while Section 3 includes our hypothesis development. Section 4 explains the research methodology; Section 5 displays the main findings; Section 6 analyses earnings management and the expected oil price; Section 7 explores the impact of Covid-19, and Section 8 presents the conclusions.

2. Literature review

The earnings smoothing "reflects the ongoing and overtime use of income-increasing and income- decreasing accrual and real activities earnings management to reduce the volatility of reported earnings" (Demerijan et al., 2020, p. 409). Managers smooth income, considering both current and future performance (Fudenberg and Tirole, 1995). In periods with poor current earnings and high expected future earnings, managers have the opportunity to shift future earnings into current periods, “borrowing” from future periods. In periods with high current earnings and poor expected future profits, managers have the opportunity to shift current period profits in the future (De Fond and Park, 1997).

Earnings smoothing is not exempt from costs being based on forecasts. If managers’ earnings forecasts are inaccurate, the costs of smoothing may substantially increase. Earnings smoothing may lead to misreporting (Schrand and Zechman, 2012). If a manager “borrows” earnings from future periods and the expectations are not afterwards realized, more aggressive accounting discretional choices would be needed to maintain the earnings trend set (Baik et al., 2020). This might the frequency of misstatements, enforcement actions and litigations (Myers et al., 2007). Also, if aggressive earnings management is detected, managers can lose credibility and experience negative reputational and career consequences (Desai et al., 2006; Hazarika et al., 2012).

The abovementioned considerations suggest that smoothing requires significant ability to forecast the firm’s future profits (Demerjian et al., 2020). Forecasting future earnings is crucial to avoid the potential costs of smoothing. Two critical factors drive managers' forecasting: the availability of quality information regarding the firm’s internal operations (e.g. costs, investments, human resources) and the economic prospects (e.g., market demand, competition, industry trends). The second is the managers’ ability to process this information (Goodman et al., 2014).

Prior studies investigated the relation between earnings smoothing and managerial ability (Walker, 2013). These researches suggest that a superior ability to forecast the firm’s future economic perpspectives is associated to income smoothing, because it decreases the potential costs of the smoothing decisions (Demerjian et al., 2020; Baik et al., 2020).

However, prior research dedicated scant attention to the relationship between the information used for forecasting and the earnings smoothing decisions. Schipper and Vincent (2003) argues that managers with superior information facilitate earnings smoothing. Ittner and Michels (2017) find that firms integrate a richer set of risk-based information in their forecasting issue more reliable earnings forecasts. Bamber, Jiang, and Wang (2010) claim that managers able to gather and elaborate significant information make more accurate forecasts. Previous studies highlighted that the quality of information available to the firm is crucial to managerial decisions (Gallemore and Labro, 2015). However, such literature did not address which type of information the managers use for earnings analyses. This paper argues that using a portfolio of price information influences earnings smoothing decisions. This research investigates the oil commodity firms, a setting in which the critical information for estimating future earnings, that is, the commodity price, is observable.

3. Hypothesis development

The commodity businesses have a history of price volatility (Diaz et al., 2016; Regnier, 2007). International supply and demand, as well as political factors beyond firms' control, affect the commodity price (Carter et al., 2017). While having relative stability in the firm's internal operations (Damodaran, 2009), commodity firms experience high volatility in the industry trend, product demand and thus in the revenues and earnings. The portfolio of information related to commodity price is thus a critical factor of the managers' estimation of the future earnings, which is at the core of earnings smoothing and the related communication to financial actors.

Prior research suggests a plausible association between commodity price and earnings management to reduce earnings volatility (Petersen and Thiagarajan, 2000; Barton, 2001; Pincus and Rajogopal, 2002). Managers of commodity firms can use the complete portfolio of price information available to forecast and plan earnings better. An informed superior understanding of the firm's economic prospects would allow managers to forecast earnings accurately and, thus, engage in earning smoothing decisions more accurate (Baik et al., 2020). Hence, we expect that managers of commodity firms use a portfolio of information available about the commodity price (e.g. price trend, volatility, expected future price) to implement earnings smoothing decisions based on forecasts.

However, earnings smoothing is not exempt from costs such as financial misreporting, enforcement actions or litigations (Desai et al., 2006; Hazarika et al., 2012; Schrand and Zechman, 2012). The commodity price volatility is likely to challenge the managers' ability to estimate future earnings and could make earnings smoothing costlier for them[1]. Demerijan et al. (2020) clarify that to reduce volatility, managers use continuing income-increasing and income-decreasing earnings management. Excessive volatility for prolonged periods or sudden price shocks makes smoothing riskier for managers. Many political, social, economic factors and natural events can influence the demand and supply of commodities, increasing volatility and even create sudden price shocks (Damodaran, 2009; Dayanandan and Donker, 2011). Hence, based on the information available about the commodity price, managers may not engage in earnings smoothing activity due to risks, for example of financial misreporting, litigations or career damages (Baik et al., 2020).

Decision theory observes that the type and quality of the information based on decisions affect decisions' quality and outcomes (Gallemore and Labro, 2015). Hence, the firm's ability to implement earnings smoothing activities is likely to be affected by the types of information used by the managers.

The above considerations suggest that the availability and the use of a portfolio of information on the commodity price plays a crucial role in earnings smoothing decisions. Whether the information on commodity price leads or not to earnings smoothing is an empirical question to address. We formulate and test the following hypothesis.

> **HP***:* There is an association between earnings smoothing and commodity price information.

[1] An alternative strategy to cope with the commodity price volatility could be the use of hedges. Prior literature produced mixed results on the effectiveness of hedging in creating value by reducing earnings volatility (Pincus and Rajgopal, 2002; Guay and Kothari, 2003; Jin and Jorion, 2006). Pincus and Rajgopal (2002) find that commodity-price hedging positions are independent of decisions on earnings management. Due to the nature of contracts having effects in the fourth quarter, hedging is less effective in managing the commodity price risk at the level of quarterly results, with the latter being used by market participants when valuing stocks. For this reason, Jin and Jorion (2006) insist that hedging does not affect market value in the oil industry.

4. Research methodology

4.1. Sample

The empirical analysis uses oil firms' quarterly data obtained from the Compustat database. We downloaded the quarterly data for active and inactive US public firms classified under the Standard Industrial Classification (SIC) codes 1311 (exploration and production) and 2911 (petroleum refining). The data are available on Compustat North America from 1986 Q1 to 2019 Q4 and facilitate the design of a unique longitudinal dataset to generate strong empirical results that effectively extend previous literature and provide supportive evidence for practitioners and public analysis. The chosen longitudinal dataset covers the maximum period currently available to analyze the data.

The focus is on US oil firms because they represent the most crucial segment of the global oil industry with important international implications (IEA, 2020). Even though other major oil firms exist outside the US setting, the US firms present the most extensive grouping to test the models, also considering data availability. The SIC 1311 firms represent the upstream side of the oil and gas value chain. Upstream operations comprise the exploration, testing and drilling of oilfield sites – all of which are required procedures to extract oil from the ground. The SIC 2911 firms represent the downstream side of the oil and gas value chain. Downstream operations include pipelining crude oil to refining sites, manufacturing oil-based products.

The use of company quarterly financial data better captures earnings management in the oil industry, given the volatility of the oil price across quarters and its impact on the reported performance (Byard et al., 2007; Han and Wang, 1998). Historical data on the oil price is publicly available on the US Energy Information Administration (EIA) website.[2] We use the West Texas Intermediate Free on Board (WTI FOB) price in dollars per barrel.[3] The time series available on the EIA website run from January 1986.

The sample consists of 2,509 firm-year observations, 1,933 firm-year observations classified as SIC code 1311 (exploration and production), and 576 firm-year observations classified as SIC code 2911 (petroleum refining). The number of individual firms is 139 for SIC code 1311 (exploration and production) and 31 for SIC code 2911 (petroleum refining).

3.2. Research design

Prior research on oil firms' used accrual earnings management models, augmented with an additional independent variable (a dummy), proxying for specific periods of high oil prices – with zero if the oil price was low and one if it was high (Byard et al., 2007; Han and Wang, 1998; Hsiao et al., 2016). We extend this research design and include the oil price information as an additional variable in multiple accrual earnings management models. In this way, we examine the effect of price information on total accruals. Furthermore, we add the oil price information to real earnings management models (Roychowdbury, 2006), examining the effect of price information on production costs and discretionary expenditures.

This single equation approach is consistent with prior research on earnings management in oil firms. It also follows the recent recommendations by Chen et al. (2017) to include the

[2] Available on http://www.eia.gov/dnav/pet/pet_pri_spt_s1_m.htm

[3] The WTI trades in Cushing, Oklahoma. It is a primary benchmark for the oil price and the benchmark for futures contracts trading on the NYMEX.

explanatory variable in single equation earnings management models and avoid using residuals (i.e. discretionary/abnormal accruals/real) as dependent variables[4]. This approach also allows examinining the whole portfolio of earnings management strategies available (Zang, 2012; Duong and Pescetto, 2018; Garcia Lara et al., 2020).

Prior research on earnings management in oil firms use self-developed accruals earnings management models[5]. To avoid subjectivity in the selection of the variables we use a set of accrual earnings management models consolidated in the literature: (a) the Jones (1991) discretionary total accruals model; (b) the modified Jones model (Dechow et al. 1995); (c) the Jones model augmented with ROA; and (d) the modified Jones model augmented with ROA (Alissa et al., 2013; Kothari et al., 2005). The correlation between total accruals and oil price information should display a positive sign, as higher prices imply higher profits for oil firms (Byard et al., 2007; Han and Wang, 1998). A negative correlation would suggest that firms are managing the accruals downward by reporting earnings that should be higher for a given level of the oil price (Han and Wang, 1998).

We also use real earnings management models by Roychowdbury (2006) and their modified versions by Gilliam (2021) related to production costs and discretionary expenses. Since the finished product is a commodity, the value of the inventory is made primarily by overheads and indirect costs, leaving ample room to use operations to manage earnings. Oil price is primarily driven by the demand and should have a positive effect on quarterly production costs and on its components: the cost of goods sold (COGS) and the change in the inventory. A negative sign on the change in inventory could signal real earnings management aimed at slowing production, to keep higher portions of overheads and fixed costs in the cost of goods sold when the oil prices are high and viceversa. This behaviour would be consistent with anectotal and practioners' evidence that oil firms build inventories in periods of low prices and slow inventory replenishment in periods of high prices (New York Times, 1976; Caffarra, 1990; Fattouh et al, 2020). Finally, a positive correlation between quarterly oil price and quarterly discretionary expenses may signal real earnings management aimed at smoothing quarterly earnings[6].

To test our hypothesis, we estimate the following models:

$$\mathrm{TotalAccruals}_{it} = \beta_i \frac{1}{\mathrm{ASSETS}_{it-1}} + \beta_i(\mathrm{JonesVariables}_{it}) + \beta_i p_t + \varepsilon_{it} \qquad \mathrm{EQ(1)}$$

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[4] As noted by Chen et al. (2017), two step procedures using residuals as dependent variable may misspecify the first step, since the explanatory variable usually affects the regressors of the first regression. For example, estimating discretionary accruals and then regressing them on the auditor tenure would neglect the fact that the tenure already affect the total accruals in the first regression, as well as other regressors. Hence, the best and most simple solution is to use single equations to study earnings management (Chen et al., 2017, p. 34).

[5] Han and Wang's (1998) model is similar to the modified Jones model. Byard et al. (2007) add other control variables for growth in total assets, market-to-book-value and leverage to Han and Wang's (1998) model. Hsiao et al. (2016) use a self-developed model similar to the modified Jones model augmented with the ROA but adds other controls for firm size, market-to-book-value and leverage.

[6] We do not include the Roychowbury (2006)'s cash flow model, as the correlation sign between oil price and cash flow is not able to signal earnings management. The sign can be either positive, due to increased prices, or negative, due to DSO. The average Days Sales Outstanding (DSO) in the industry varies over the decades, ranging from 80 days to more than 120 days (American Express and EY, 2014), which means that most of a quarter's sales are cashed in subsequent quarters. Therefore, increased sales may produce less than the proportional increases in the cash flow. Because of the timing differences between accral and cash flows, models based on accrual data are more able to signal earnings management implemented at a a quarter level.

$$\text{TotalAccruals}_{it} = \beta_i \frac{1}{\text{ASSETS}_{it-1}} + \beta_i(\text{ModJonesVariables}_{it}) + \beta_i p_t + \varepsilon_{it} \quad \text{EQ(2)}$$

$$\text{TotalAccruals}_{it} = \beta_i \frac{1}{\text{ASSETS}_{it-1}} + \beta_i \text{KothariVariables}_{it} + \beta_i p_t + \varepsilon_{it} \quad \text{EQ(3)}$$

$$\text{TotalAccruals}_{it} = \beta_i \frac{1}{\text{ASSETS}_{it-1}} + \beta_i \text{ModKothariVariables}_{it} + \beta_i p_t + \varepsilon_{it} \quad \text{EQ(4)}$$

$$\text{Production costs}_{it} = \beta_i \frac{1}{\text{ASSETS}_{it-1}} + \beta_i(\text{RoychowdburyVariables}_{it}) + \beta_i p_t + \varepsilon_{it} \quad \text{EQ(5)}$$

$$\text{DiscretionaryExpenditures}_{it} = \beta_i \frac{1}{\text{ASSETS}_{it-1}} + \beta_i(\text{RoychowdburyVariables}_{it}) + \beta_i p_t + \varepsilon_{it} \quad \text{EQ(6)}$$

where p_t is the oil price information on the t quarter in the t firms. The oil price is firm invariant for each quarter included in our analyses. We use the following market measures of oil price in order to construct the portfolio of public information used by managers: (a) the end of quarter spot price; (b) the average quarterly price; and (c) the quarterly price volatility, measured as the quarterly standard deviation of the price. These are the variables typically used in economic studies on oil price trends (Baumeister and Kilian, 2016; Ferderer, 1996; Park and Ratti, 2008) and in studies on the oil price and financial performance (Bagirov and Mateus, 2019; Gupta, 2016; Gupta and Krishnamurti, 2018). From an econometric-analytical perspective, the inclusion of oil price information in earnings management models also provides a quarter-by-year effect since the oil price incorporates seasonal (quarterly) effects and time (year) effects, as well as the macroeconomic trend (Ferderer, 1996; Ratti and Vespignani, 2016). We use the logarithmic transformation of the crude oil price to normalize the price series and avoid the exponential trend's effect.

We also include a fourth measure of oil price information in our earnings management models, namely the expected quarterly price. This price is measured in two ways: (a) an expected oil price predicted through an ARIMA forecasting model, and (b) the oil price indicated in the NYMEX WTI crude oil futures. The first way simulates a possible price forecast made by oil firms. The second way uses the NYMEX oil futures contracts; the time series are available on the EIA website.[7]. The two ways are complementary because they enable analysts to consider both a company forecast and an external market forecast of the oil price, thereby increasing the validity of the analysis.

There are four types of future oil contracts. For crude oil, Contract Type 1 expires on the third business day before the 25th calendar day preceding the delivery month. The monthly price of Contract Type 1 is the price that can be obtained for the deliveries of the following month. Contract Types 2, 3 and 4 represent the successive delivery months. The Contract Type 1 oil price is usually remarkably close to the current price, while Contract Type 2, 3 and 4 prices incorporate the forecast about the oil trend and diverge from the current price. Section 5 includes the results obtained using the price of Contract 3 futures, namely those related to deliveries generally occurring in the next quarter to the date of the contract. Therefore, the Contract 3 future price is a benchmark for the oil price in the next quarter. We also use Type 2 and Type 4 as a robustness check. Given the research design, this study can be fully replicated using publicly available data.

Table 1 summarizes the measurement of the variables, while Table 2 summarizes the earnings management models used. All financial variables are winsorized at 1%.

[7] The data are available at http://www.eia.gov/dnav/pet/pet_pri_fut_s1_m.htm

We estimated our accrual earnings management models using the feasible generalized least square (FGLS) estimator to control both for heteroscedasticity and serially correlated error terms (AR(1)) (Baltagi and Wu, 1999; Hansen, 2007b; Romano and Wolf, 2017). More specifically, because we used unbalanced panel data in our analysis, the error terms over the cross-sectional units are likely to be different from the error process of a given cross-sectional unit over time, and the assumption of the ordinary least squares (OLS) could be violated (Baltagi and Wu, 1999; Collins and Dent, 1984). Under these circumstances, the error terms in the model may be heteroscedastic and serially correlated (AR(1)). Consequently, the ordinary least squares (OLS) estimator is likely to be biased and generalized least square (GLS) is an unbiased estimation procedure (Hansen, 2007).

As error variances are typically unknown, we use a feasible specification of generalized least square (FGLS) to obtain more reliable results (Hansen, 2007b). Following Baltagi (2006), we use both parametric and nonparametric estimation of the error variances and combine the semiparametric FGLS estimators. All these methodological choices ensure unbiased results.[8]. The use of the FGLS method to analyze the effect of price mechanisms on earnings management in the oil industry appears the most convenient for our data features. In the presence of unobserved characteristics, this method produces more efficient and consistent estimates than the OLS method.

5. Main empirical analyses

5.1. Summary statistics

Table 3 displays summary statistics for the oil price. In the time series 1986 Q1 to 2019 Q4, the quarterly spot price (p_t) was on average \$49,28 per barrel, with the median being \$43,15. The price is positively skewed (0.653) with a high level of kurtosis (2.273), indicating substantial deviations from normality.

Table 3 (continuation) reports the summary statistics related to the entire sample and the two subsamples. It also reports the difference in the means to emphasize that, for most variables, the difference is statistically significant. We comment on some rough data to provide a better indication of these firms' features. The SIC code 1311 firms have on average total assets of about 5.6 billion \$ and the average quarterly sales on total assets are about 0.154. The SIC code 2911 firms have on average \$119.6 billion in assets and the average quarterly sales on total assets are about 0.231. The SIC code 1311 firms have a quarterly average cash flow from operations on total assets of about -0.156 (median 0.033), while the cash flow from operations in the SIC code 2911 is 0.050 (median 0.105).

5.2. Univariate analysis

The univariate analysis (displayed in Table 4) shows that our measures of the WTI quarterly spot price (p_t) and the WTI average quarterly price ($\bar{p}_t$) have a significant negative correlation

[8] We also ran the ordinary least square (OLS) regression with fixed effects specification instead of an FGLS. We obtained results consistent with those reported in the following sections of the paper.

with total accruals, with a p-value <0.05. This correlation hints at potential earnings management, as oil firms usually display higher accruals and boost profits as the oil price increases. The WTI quarterly price volatility (σ_{pt}) is also negatively and significantly correlated with total accruals, with a p-value <0.05. This result suggests that oil firms adopt a downward revision of their accruals in the presence of volatile oil prices. The two price measures indicate that oil price measures do not significantly correlate with firms' sales and profitability. The σ_{pt} appears to affect the sales negatively, and the correlation coefficient is significant at the 1% level.

5.3. Multivariate analysis

Table 5 shows the results obtained by regressing the modified Jones model with the ROA (Kothari, 2005), augmented with the natural logarithmic of the WTI quarterly spot price (p_t) in Column 1, with the WTI average quarterly price ($\bar{p}_t$) in Column 2 and with the WTI quarterly volatility (σ_{pt}). The results explained below are consistent with all the accruals management models considered in the research (Jones Model, Modified Jones Model, Jones Model with ROA, Modified Jones with ROA). For brevity reasons, we report the results obtained with the Modified Jones model with the ROA. The others are available in a supplemental file.

Table 5, Column 1 shows that the quarterly spot price has a significant negative correlation with total accruals, with a p-value <0.01. The adjusted sales (ΔS_t-ΔR_t) have a significant positive correlation with the p_t (p-value <0.01). The association sign indicates that increased sales are driven by higher market demand, which also influences the price. Table 5 Column 2 confirms the abovementioned results using the WTI average quarterly price ($\bar{p}_t$) instead of the WTI quarterly spot price at the end of the quarter. Also, in this case, $\bar{p}_t$it displays a significant negative correlation in all the models (p-value <0.01). The control variables related to the adjusted sales ((ΔS_t-ΔR_t) displays a significant coefficient in the expected direction.

Our findings suggest that oil firms use income-decreasing accrual earnings management in quarters with a high oil price. Vice versa, they use income-increasing accrual earnings management in quarters with low oil price. Oil firms appear to use accruals to shift profits across quarters and smooth earnings despite changes in the oil price.

Table 5, Column 3, shows the regression of accrual earnings management models using the WTI quarterly price volatility (σ_{pt}). The price volatility is a measure of how much the oil price changes during a given quarter. σ_{pt} is significantly and negatively correlated with total accruals in all the models, with p-value <0.01[9]. These results suggest that oil firms smooth their earnings in response to the commodity price volatility. By engaging in income-decreasing accruals management, oil firms shift current profits in future quarters.

The effect of the price information on earnings smoothing is economically relevant. For instance, the coefficient estimated on $p_t$means indicates that total accruals decrease by 0.0216% for every 1% increase in the oil price (Wooldridge, 2010). If we consider the median values, an

[9] We also ran our analyses using the oil price volatility in the quarter t and t-1 (6 months) instead of on price volatility in quarter t. We obtained results consistent with those reported in the next section.

increase of about 43 cents in the oil price (1% of 43.15$, the median oil price in the sample) implies a decrease in the total accruals worth 47.18 million $ (the median total accruals are 2,097 billion $ in the whole sample). The effect is economically relevant compared to the overall average total accruals and the quarterly average net income, which is about 1,69 billion $ in our sample. This is our most conservative estimate of the commodity price information economic magnitude. Considering the coefficient obtained with the Jones model, the decrease in total accruals would be about 0.0225% for a 1% increase in the oil price (see supplemental data). The average quarterly price information ($\bar{p}_t$) and the quarterly oil price volatility (σ_{pt}) also significantly affect economically. A 1% increase in the quarterly average oil price implies a decrease of 0.0223% in the total accruals, and a 1% increase in the quarterly oil price volatility decreases the total accruals by 0.0271%.

Table 6 displays the results obtained using real earnings management models. To ascertain whether there is earnings management, we decompose the production costs considering its two components: the COGS and the change in inventory (Roychowdbury, 2006). Table 6, column 1, show that the quarterly WTI price has a positive correlation with production costs (p-value <0.01). When we decompose the production costs, we find that the quarterly price has a positive significant association with the cost of goods sold (p-value <0.05) and a negative association with the change in inventory (p-value <0.10). Whilst the change in inventory is positively correlated with the trend in the sales (p-value <0.01 either for sales and for past changes in sales), the oil price correlation sign with the change in inventory is unexpected and signals real earnings management. It suggests that in quarters features by high oil price, despite the demand, the inventory does not grow proportionally and higher stakes of indirect costs are kept in the COGS, thus smoothing the quarterly earnings. Viceversa, in quarters with low oil price, increases in inventory reduce the COGS, thus increasing the quarterly earnings (Roychowdbury, 2006). Oil firms use production operations to manage earnings. Some overproduction in quarters featured by low oil price helps lowering the cost of goods sold by charging more indirect costs and overheads to the inventory, whilst some underproduction produces the opposite effect in quarters featured by high oil price. Table 6, columns 7 and 11 shows that the change in inventory is negatively correlated either with the the average quarterly oil price $\bar{p}_t$ and with the quarterly price volatility (σ_{pt}).

Other evidence of real earnings management appears in Table 6, columns 4 and 8. The discretionary expenses have a positive significant association with the oil price (p-value <0.10 for the quarterly price and <0.05 for the average quarterly price), whilst they have no significant association with the sales. This findings suggest that oil firms use discretionary expenses to decrease (or increase) the quarterly income in quarters in which the oil price is high (or low). To ensure robust findings we run the analyses also using Roychowdbury (2006) models as adjusted by Gilliam (2021). We obtained consistent results reported in a supplemental file.

5.4. Cross-sectional results on SIC 1311 (exploration and production) and SIC 2911 (petroleum refining)

Following previous research on earnings management in oil firms (Byard et al., 2007; Han and Wang, 1998; Hsiao et al., 2016), we also performed a cross-sectional analysis on SIC code 1311 (exploration and production) and SIC code 2911 (petroleum refining) firms and separate analysis. Despite being commonly considered a homogeneous group, the oil industry is composed of two specific SIC codes. SIC code 1311 and SIC code 2911 firms have different business models. Exploration and production firms produce the commodity and sell their output to other businesses. Petroleum refining firms manufacture and distribute a wide range of products to other businesses and consumers, including gasoline, gas, fuel, chemical components, and asphalt.[10].

Table 7 presents the FGLS estimation of the Modified Jones model with the ROA, augmented with p_t, $\bar{p}_t$ and σ_{pt} for the SIC code 1311 and the SIC code 2911. Again, the results explained below are consistent with all the accruals management models considered in the research. To be concise, we report the results obtained with the Modified Jones model with the ROA. The others are available in a supplemental file.

The results show that p_t and $\bar{p}_t$ have a significant negative correlation with the total accruals in the SIC 1311 subsample (Table 7, columns 1 and 2). These results are consistent with those previously reported on the entire sample. They suggest that SIC code 1311 firms use income-decreasing earnings management in quarters with a high oil price.[11]

Table 7, column 3, also reports the estimation of the Jones model augmented with σ_{pt} for the SIC code 1311 subsample: the oil price has a significant negative association with the total accruals. These results are consistent with those previously reported on the entire sample and confirm that SIC code 1311 firms reduce accruals in quarters with higher volatility of oil prices.

The effect of price information on earnings management is economically significant. Indeed, the coefficient estimated on $\bar{p}_t$means in Table 7 column 2 indicates that a 1% oil price increase implies a 0.0175% decrease in the total accruals. Hence, for every 43 cents increase in the oil price (1% of the median oil price in the sample), the SIC Code 1311 firms total accruals decrease by about 5 million $, as the median total accrual for these firms is 272,39 million $. The effect is economically relevant compared to the overall average total accruals and the quarterly mean net income for SIC Code 1311 firms, which is about 421 million $ in our sample.

Table 7, columns 4, 5 and 6, shows the results obtained from running the accrual earnings management models augmented with the price information for the SIC Code 2911 subsample. p_t has a positive significant association with total accruals (Table 7, column 4). $\bar{p}_t$ also has a positive significant association with total accruals, with p-value <0.01 (Table 7, column 5). For SIC code 2911 firms, there is no evidence of smoothing. Instead, the average quarterly oil price seems to push total accruals upward. These firms appear to benefit when oil prices increase, with higher profits, as suggested by the literature and evidence gathered by governmental

[10] See the SIC code description of the US Department of Labor available at https://www.osha.gov/pls/imis/sic_manual.display?id=627&tab=description.

[11] The dataset and all results (reported and not reported) may be requested from the authors.

agencies and practitioners (Baaij et al., 2011; EIA, 2019; Dayanandan and Donker, 2011; Gupta, 2016; The Guardian, 2020).

The oil price volatility (σ_{pt}) has no significant association with total accruals in SIC 2911 firms (Table 7, column 6). This result also suggests SIC code 2911 firms do not use accrual management to lower earnings as a hedge against oil price volatility.

Unlike SIC Code 1311 firms, the SIC code 2911 firms do not use earnings management following oil price fluctuations because they already have a business model that protects them against commodity price volatility. A stream of energy economics literature shows that oil-related consumer products of petroleum refining firms (SIC code 2911) asymmetrically respond to oil price changes (Radchenko, 2005). For example, lower gasoline prices do not follow oil price declines with the same speed as higher gasoline prices follow oil price increases (Bachmaier and Griffin, 2003; Radchenko, 2005; Rahman, 2016). It means that when the oil price decreases, petroleum refining firms slowly adjust gasoline prices, profiting from the asymmetry. Residential consumers' energy and gas prices also tend to be stable, thanks to commercial practices and regulations by the authorities (EIA, 2013).

Table 8 shows the results obtained by regressing the real earnings management models by SIC Code, including the quarterly oil price (for brevity reasons, and because the results are consistent, we do not include the regression using the quarterly average price and the volatility).

Table 8, column 3 shows that for SIC code 1311 firms the cost of goods sold has a positive significant association with the oil price (p-value <0.05), whist the change in inventory has a significant negative association (p-value <0.05). SIC code 1311 firms' core business is the production of the oil commodity. This finding suggest that these firms adjust quarterly production to smooth earnings. After controlling for the sales level, for every 1% increase in the oil price the SIC Code 1311, firms decrease the inventory by about 150.000 $ and increase the COGS by about 1.6 million $. Although the decrease in the inventory may appear less material, the important issue is the additional overheads and indirect cost kept in the COGS[12]. The income-decreasing effect is added to that produced by accruals earnings management. The correlation between discretionary expenses and oil price is near to the significance, but not significant in SIC Code 1311 firms (Table 8, column 4). It is significant at the 10% level when using the average quarterly oil price (untabulated).

SIC Code 2911 firms do not use inventory, but use discretionary expenses to reduce the quarterly reported earnings. Table 8, column 8, shows that the discretionary expenses have a positive significant association with oil price (p-value <0.01). Unlike SIC Code 1311 firms, which are focused on one product, SIC Code 2911 firms have different types of inventories (gas, gasoline, other products like asphalt) and large consumer markets. Hence, it could be easier to manipulate operations related to discretionary expenses rather than production processes.

[12] This finding is consistent with anectodal evidence that, despite production capability, oil firms are reluctant to ramp up production in periods of high prices for reasons like the fact that overall some undersupply is preferable over some oversupply to reduce the risks of gluts and price crashes (Caffarra, 1990), or the idea that some undersupply helps political negotiations over new regulation - see the recent row between President Joe Biden and US oil firms over supplies (CNN, 2021).

To ensure robust findings we run all the analyses by SIC Code also using Roychowdbury (2006) models as adjusted by Gilliam (2021). We obtained consistent results reported in a supplemental file.

5.5. Addressing endogeneity concerns: the exogenous shock of China's entry into the WTO

This section addresses endogeneity concerns by examining the exogenous shock caused by China's entry into the WTO. In September 2001, China became a member of the WTO. This development resulted in a rapid increase in oil demand. Accordingly, crude oil prices increased dramatically as a result of China's higher demand for oil. China's growing role as an oil consumer also had a tremendous impact on the global economy. China is among the largest consumers of oil with 10% annual growth rates since 2001[13]It is crucial to understand the impact of an exogenous shock concerning oil prices on oil firms' earnings management. Because China's entry into the WTO was unexpected, it qualifies as an exogenous shock. Therefore, we estimated two-stage least squares models (2SLS) using the US crude oil export rate to China as an instrument (ExportChina)[14].

The export rate serves as a proxy of crude oil demand. The growth in China's oil demand induced a substantial shock in the oil price series. Simultaneously, the growth in oil exports had no direct influence on firms' earnings management. We, therefore, ran a battery of 2SLS regressions using the natural logarithmic of US crude oil export rate to China as an exogenous shock to the oil price. Table 9 presents the 2SLS regression results obtained using the Modified Jones Model with ROA: column 1 reports the results obtained on the full sample, whilst columns 2 and 3 the results obtained on the SIC 1311 subsample and the SIC 2911 subsample, respectively (the results obtained using other accrual management models are available in a supplemental file).

We also examined other endogeneity concerns. Endogeneity occurs because earnings management can be driven by time-invariant, correlated omitted variables (Bartov et al., 2000; McNichols, 2002). We performed a firm fixed effects specification using the generalized method of moments (GMM) to address the potential endogeneity issue (Cascino, 2017; Eugster, 2020; Hann et al., 2020). The GMM dynamic model uses lagged values of both the dependent and independent variables as instruments, uncorrelated with the error terms. The impact of oil price on earnings management is determined precisely, using the GMM dynamic panel model accounts for firm fixed effects (Mellado-Cid et al, 2019). According to the Blundell and Bond approach (2000), the unobserved firm-specific heterogeneity is dropped by using a first differencing transformation. The model contains unobservable level effects correlated with the lags of the dependent variable (Blundell and Bond, 2000). In the GMM model, total accruals and oil price are treated as endogenous. We use ten lags for the instruments. To assess the reliability of the GMM estimates, we applied Sargan's (1958) test to evaluate the validity of the instrumental variables.

[13] China's National Bureau of Statistics (NBS).
[14] The data is available at https://www.eia.gov/dnav/pet/pet_move_expc_a_EP00_EEX_mbbl_m.htm

Table 10 shows the GMM estimation of the Modified Jones with ROA model (the GMM regression the other accrual earnings management models are available in a supplemental file). The results remain consistent with those of the primary analysis reported above. The validity tests confirm the validity of our instrumental variables. The first-order serial correlation – AR (1) shows a significant result across columns 1, 2 and 3 (p-value < 0.05), suggesting that the residuals in the first differences are correlated. Table 10 also reports the second-order correlation – AR (2) – and Sargan's over-identification test in all our earnings management models. Sargan's statistical results (Arellano and Bond, 1991) confirm that our instruments are valid and exogenous.

The results show that our analyses are robust to the endogeneity. There is a negative association between quarterly oil price and total accruals across both the entire sample (Table 10 Column 1) and the SIC code 1311 subsample (Table 10 Column 2), while the oil price is positively associated with total accruals in the SIC code 2911 subsample (Table 10 Column 3). The control variables have the expected sign across the columns. We ran endogeneity checks also on real earnings management models, obtaining evidence that our are robust to the endogeneity (untabulated).

6. Earnings management and expectations about the future oil price

6.1. Oil price forecast

A given quarter's earnings management may be driven either by the historical oil price as a proxy of the future oil price or by the managers' expectations of the future oil price in the next quarters. We used an ARIMA forecasting model to estimate an expected future price based on historical oil price data in the first case. In the second case, we used the oil price information indicated in the NYMEX futures contracts, which is an external reference for the managers' decisions when estimating the future oil price (Baumeister and Kilian, 2016).

Before forecasting the expected values, we examined the time-series features of prices. To analyze the stationarity and determine the order of integration of our price data, both in levels and in differences, we applied the standard unit root tests: the Augmented Dickey-Fuller's (ADF) statistic (Dickey and Fuller, 1981) and the Phillips-Perron (PP) test (Phillips and Perron, 1988). We used the Akaike information criteria (AIC) to select the lag length from the abovementioned tests. We also performed the Elliott-Rothenberg-Stock (1996) DF-GLS test by removing the potential trend in the oil price data. According to economic studies on oil price, the level series of oil prices is integrated of order one I (1), while the first difference price series is stationary I (0) (Arouri et al., 2011; Cunado and Gracia, 2005; Perron, 1989).

A key concern regarding the crude oil price is the presence of structural breaks. Evaluating the structural changes and the parameters' stability over time allows firms to assess the volatility associated with cyclical changes in oil markets (Lee et al., 2010). Therefore, to assess the probability of structural breaks in the oil price series, we implemented the Zivot and Andrews (2002) and the Clemente-Montanes-Reyes (1998) break tests. The latter simultaneously considers two possible structural breaks in the series (Baum et al., 1999). Its advantage is that it requires no a priori knowledge of the structural break dates.

The results shows a structural break in the oil price series around 2004 Q2 (see supplemental file). The rapid growth in oil demand by emerging economies could have driven the global oil price by affecting a structural shock around 2004 Q2 (Kesicki, 2010). Indeed, from September 2003 to April 2004, crude oil prices increased dramatically due to meeting the higher oil demand of China and other emerging economies (Kilian, 2009; Salisu and Fasanya, 2013). The time-series analyses show that oil price series are non-stationary, non-linear and highly persistent. The results of the ADF test, the PP test, the DF-GLS and the Zivot-Andrews test are reported in Table 1 – Appendix.

Considering the specific characteristics of oil price data, we used the ARIMA (p, d, q) model (Box et al., 2015) to predict the future expected values of the oil price based on historical oil price data. The ARIMA model of degree of AR (p), the difference (d) and MA (q) can be expressed as:

$$p_t = \mu + \lambda_1(p_t - p_{t-1}) + \theta_1(\varepsilon_t - \varepsilon_{t-1})$$

Where p_t is a non-stationary oil price time series at time t, and εt is the error term assumed as white noise (zero mean and constant variance).

To implement the forecasting procedure, we first used the AIC to determine the optimum orders of autoregression (p), differencing (d) and moving average coefficient (q). Based on the minimum value of AIC, the optimum order is (1, 1, 1). After that, we estimated the parameter of the ARIMA and finally used these estimated parameters $[\hat{p}_t]$ to predict the future oil price E$[p_t]$ (Callen, 2009; Box et al., 2015; Tan et al., 2010).

6.2. Empirical results

Table 11 reports the results obtained, estimating the Modified Jones Model with the ROA accrual earnings management model, augmented with the expected future WTI quarterly price at t+1 E$[p_t]$. The expected future price has a significant negative association with total accruals in the full sample (Table 11, column 1). This result suggests that oil firms forecast oil prices based on historical oil price data to engage in accrual earnings management. The control variables have the expected sign.

Table 10 displays the results obtained by running a separate analysis on the SIC code 1311 (exploration and production) and the SIC code 2911 (petroleum refining) subsamples. The results confirm that these two groups behave differently. SIC code 1311 firms use income-decreasing accrual earnings management when they expect a high price in the next quarter (Table 11, column 2).

SIC code 1311 firms elaborate their quarterly accrual earnings management by considering the closing quarter and the expected price in the following quarters. Further investigations (un-tabulated due to space constraints) prove that total accruals have a significant negative association with the expected future oil price at *t+2* and *t+3*, along with a weak significance level at *t+4*. The time horizon used to determine earnings management policies appears to range from the closing quarter to *t+3*, considering the current level of the oil price and the expectations regarding the next three quarters.

By contrast, there is no evidence of accrual earnings management in SIC code 2911 firms, as the E[p_t] has a positive correlation sign, signalling that the total accruals increase when the oil price increases (Table 11, column 3). The analyses of the expected future price at *t+2* and *t+3* confirm this result (un-tabulated due to space constraints). Un-tabulated results (available in a supplemental file) show that we obtain consistent findings also using other accruals management models.

Table 12 shows the results obtained augmenting the accrual earnings management model with the NYMEX WTI crude oil future (Contract 3) ($future_{pt}$) for all the sampled firms. The oil price in NYMEX futures contracts (Contract 3) is the price that is paid for deliveries in quarter t+1 (three months from the date of the contract). *The* $future_{pt}$ has a significant negative association with total accruals in the whole sample (Table 11, Column 1). In Table 12, column 2, the correlation coefficient of $future_{pt}$ is negative and significant at the 1% level, suggesting that SIC code 1311 firms engage in income-decreasing accruals management when the oil price in futures contracts increases. The coefficient -0.017 is similar to the coefficient obtained using the average quarterly price (Table 7, column 2) and higher than the coefficient obtained using the quarterly sport price (Table 7, column 1). It indicates that the information about the future oil price has the same weight as the current quarterly price trend in the earnings management decision. Un-tabulated results show that NYMEX futures Contract 4, that is, the price paid for deliveries in q+2, also has a significant negative association with total accruals.

The effect of the future oil price on total accruals is economically significant. For 1311 SIC Code firms, a 1% increase in the oil price decreases the total accruals by 0.017% (see Table 12, Column 2). The decrease is worth million $. The economic significance of the future oil price information for the total accruals equals the economic significance of the past quarter price. It confirms that oil firms jointly consider the price trend information in the earnings smoothing decision.

Table 12, column 3, shows the results related to SIC code 2911 firms. These firms do not appear to engage in accrual earnings management, and the accruals level follows the oil price trend captured by the futures. We obtained consistent results with other accrual earnings management models (available in a supplemental file).

Un-tabulated results show that the expected oil price and NYMEX future contract price are not associated to production costs in SIC Code 1311 firms. The cost of goods sold coefficient has a positive sign and the change in inventory coefficient has a negative sign, as in the models of Table 8 (columns 2 and 3), but they are not significant. This finding suggests that the information on the future price play a lesser role than the information on the current price in production processes decisions. For SIC Code 2911 firms, the discretionary expenditures have a significant positive association with the expected price in t+1 and with the NYMEX future contract 3 and contract 4 price (p-value <0.01 in all the cases), suggesting that information about the future price influences this real earnings management decision. Exploliting future information, SIC Code 2911 firms accrue discretionary expenditures across quarters to smooth earnings.

7. Earnings management in 2020's first and second quarters: the effect of Covid-19

This section explores the effect of the Covid-19 and the sudden, massive drop in the oil price on the earnings management that US oil firms established over the past decades. The pandemic triggered a global economic crisis, exacerbated by the lockdowns imposed by the governments in an attempt to slow its spread. The worldwide hibernation of economies caused a dramatic fall in oil demand. For the first time in history, the WTI oil price fell from $60 per barrel at the beginning of 2020 to below zero values in late April and then increased to $40 per barrel in July 2020 (IEA, 2020; Financial Times, 2020, Wall Street Journal, 2020).

An in-depth assessment of Covid-19's impact is expected in the next few years, as the crisis was still ongoing at the time of the writing. We nevertheless attempt to provide timely exploratory evidence on whether the pandemic changed oil firms' earnings management practices of the past decades, considering the influence of exogenous and macro shocks on earnings management (Trombetta and Imperatore, 2014).

To this aim, this study regressed the accrual earnings management models augmented with the WTI quarterly spot price (P_{2020}) for the period from 2019 Q4 to 2020 Q2. The analysis considered the Jones model and the Jones model augmented with the ROA, examining a tailored sample (i.e., all the SIC code 1311 and SIC code 2911 firms) and the SIC code 1311 subsample (the 2911 subsample alone includes too few observations to run the analysis). The entire sample included 299 firms and 308 observations. We also ran the models adding two interaction terms among the oil prices; a dummy for 2020 Q1 (P_{2020} *2020 Q1) and another dummy for 2020 Q2 (P_{2020} *2020 Q2). The interaction terms are helpful to assess the effect of the oil price in specific quarters compared to other quarters.

Table 13 provides early evidence of the Covid-19's effect on earnings management. Column 1 shows that P_{2020} has a non-significant correlation with total accruals in the Jones model, while it has a positive but weak significant association with total accruals in the modified Jones model (Table 12, Column 2). Interestingly, the results suggest that the entire sample of US oil firms analyzed (i.e., all the SIC code 1311 firms plus a subsample of SIC code 2911 firms) does not engage in the same accrual earnings management observed over the past decades. The correlation between the oil price and the total accruals signals that the latter follows the oil price trend. The results are confirmed when replicating the analysis by adding two interaction terms for the oil price in 2020 Q1 and Q2 (Table 13, columns 3 and 4). The association between total accruals and P_{2020} still has a positive but weak significant coefficient (p-value <0.10), and the interaction terms are both positive but not significant.

Finally, Table 13 (columns 5 to 8) also reports the results obtained running the abovementioned models only on the SIC code 1311 subsample (i.e., 278 firms). The results show that P_{2020} has a significant positive association with the total accruals, with a p-value <0.01 across the columns. It suggests a change in the SIC code 1311 firms' (exploration and production) accounting discretion decisions; they do not engage in accrual earnings management anymore, as they did in past periods, as total accruals follow the oil price trend. Total accruals indeed dropped significantly with the oil price crash in 2020 Q1 and 2020 Q2.

These startling results show that the crisis ended oil firms' systematic earnings management consolidated over the decades due to the complexity to assess uncertain price information. In the COVID scenario, the oil price impacted at full force (IEA, 2020). The severity of the crisis suggests that earnings management is less practicable. The inability to forecast future prices during the pandemic first wave appears to have prevented the realization of proper earnings smoothing at a quarterly level. These findings support the notion that the information environment and the availability of price information play a key role in earnings smoothing decisions.

8. Discussion and conclusions

Our paper takes an essential step toward better understanding earnings smoothing by studying the types of price information that managers use to forecast earnings and implement earnings smoothing. The findings provide robust evidence that US oil firms use accrual and real earnings management to smooth earnings across quarters, using a full range of information concerning the quarterly sport price, the quarterly average price, the quarterly price volatility and the expected price in successive quarters. The findings also show that the relation between the oil price information and the earnings smoothing is economically significant.

The paper contributes to prior research on earnings management in different ways. This research extends the recent streams of literature that have analyzed the effect of the information environment, expressed in term of price information, on forecasting earnings and earnings management (Devos et al., 2021; Demeriajn et al., 2020; Li and Zaiats, 2017). It provides robust evidence on the types of price information considered in earnings smoothing decisions and their economic relevance, under-investigated by previous literature. Oil firms' managers assess the oil price trend, including past information and forecast information on the expected future price. The different types of price information seem to be used in a complementary manner. Managers exploit the advantage that the future price – produced by observable future contracts prices or by reliable time series estimates– is evident to them and allows more accurate future earnings estimates. Accurate estimation based on a portfolio of price information can decrease the potential costs of forecasting earnings in a volatile business environment, implementing systematic earnings management activities. Overall, our study adds to the earnings management literature with articulated and robust evidence that the analysis of the external information environment and the related types of information available are essential for understanding earnings smoothing choices.

This study also contributes to studies on the impact of the COVID-19 crisis on accounting choices at the firms level (De Vito and Gomez, 2020; Trombetta, 2020). While previous literature has started to address management control aspects (Delfino and van der Kolk, 2021; Huber et al., 2021; Passetti et al., 2021), the paper focuses on financial accounting issues. It shows that oil firms' decades-long earning smoothing activity stops in the first two quarters of 2020 with the onset of the pandemic. This finding suggests that the uncertain COVID-19 economic environment limited the oil firms' forecasting ability, making implementing proper cross-quarter earnings smoothing risky and problematic for managers.

Finally, the paper extends the literature on earnings management in the oil industry (Han and Wang, 1998; Byard et al., 2007; Hsiao et al., 2016). This paper extends this stream of literature showing that earnings management is not limited only to quarters in which the earnings are politically sensitive, but it is an ongoing, economic relevant and systematic activity spanning at least three decades. In this way, this paper answers a recent call for research to expand the research on earnings management in extractive industries (Gray et al., 2019).

The results of this paper have practical implications. Policymakers, auditors, investors and other market participants are now more informed about the reality that commodity firms, and specifically (US) oil firms, engage in earnings management in response to commodity price fluctuations. The global importance and structure of the US oil industry may generalize the results to other no-US oil markets, showing the international validity of the research. Given the economic magnitude of the earnings smoothing decisions carried out through the years by the managers, the results support the idea that specific controls – on accrual items in financial reporting – are needed in commodity-based companies where the earnings (and the stock values) are strongly dependent on commodity market prices. The regulating authorities should request a higher level of mandatory disclosure, in addition to dedicated internal controls, on the specific accrual items that oil firms can potentially manipulate to ensure reliable financial reporting. Auditing firms should also focus on reviewing specific accrual items to check for possible earnings management practices. The results also inform investors operating in the oil industry who may assess their investment decisions, considering the presence of systematic earnings management activities by oil companies.

This study acknowledges certain limitations. By following the research designs of previous studies on oil firms' earnings management, it does not directly examine the resulting benefits, for example, analyzing if investors award oil firms that have more stable earnings with a lower cost of equity or if managers achieve higher compensation when oil prices are high/low. Another limitation is that the study does not examine the weight of commodity prices relative to other factors and determinants (e.g., governance and ownership) when determining the earnings management practices of commodity-based industries.

Future research should investigate the oil industry in countries where national governments primarily control it, unlike in the US, owning either controlling stakes or having "golden share" powers. It would also be interesting to investigate if government ownership and control moderate the relation between the oil price and earnings management. Such a study can pave the way for future research on earnings management in other commodity industries, such as agriculture and mining, given the importance of and the need to study commodities industries and their specificities. Further studies concerning the information environment in which the managers operate are also necessary to further analyze earnings management.

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Table 1. Description of variables

Table 1 – Summary of the variables used and their measurement		
Measures of oil price		
Name	**Label**	**Measurement**
WTI quarterly spot price	p_t	WTI spot price at the end of the quarter *t* in year *i*
WTI average quarterly price	$\bar{p}_t$	WTI average price in quarter *t* in year *i*
WTI quarterly price volatility	σ_{pt}	WTI quarterly price standard deviation in quarter *t* in year *i*
WTI expected quarterly price	$E[p_t]$	Expected future quarterly price estimated through a time series model (details in Section 3.2)
Financial data		
Name	**Label**	**Measurement**
Total accruals	TA	Change in non-cash current assets minus the change in current liabilities excluding the current portion of long-term debt, minus amortization and depreciation from quarter *t* in year *i* to quarter *t-1* in year *i*, scaled by lagged total assets in quarter *t-1* in year i
Assets	Assets	Total assets in quarter *t* in year *i*
PPE	PPE	Gross PPE in quarter *t* in year scaled by lagged total assets in quarter *t-1* in year i
Sales	$Sale_{it}$	Sales in quarter *t* in year scaled by lagged total assets in quarter *t-1* in year i
DeltaSales	$\Delta sale_{it}$	Change in sales from quarter *t* in year *i* to quarter *t-1* in year *i* scaled by lagged total assets in quarter *t-1* in year i
DeltaAR	ΔS_{it}-ΔR_{it}	Change in Sales adjusted for the change in account receivables from quarter *t* in year *i* to quarter *t-1* in year i
ROA	ROA	Return on assets in quarter *t*-1 in year *i*
Production cost	PROD	Sum of the COGS and change in the inventory in quarter t in year i
Discretionary expenditure	DISEXP	Sum of R&D, advertising, SGA expenses in quarter t in year i

Table 2. Accrual and real earnings management models

Name with key reference in parentheses	Equation
Jones total accruals model (Jones, 1991)	$TA_{it} = \beta_0/ASSETS_{it-1} + \beta_1 \Delta SALES_{it}/ASSETS_{it-1} + \beta_2 PPE_{it}/ASSETS_{it-1} + \varepsilon_{it}$
Modified Jones total accruals model (Dechow et al., 1995)	$TA_{it} = \beta_0/ASSETS_{it-1} + \beta_1(\Delta SALES_{it} - \Delta ARit)/ASSETS_{it-1} + \beta_2 PPE_{it}/ASSETS_{it-1} + \varepsilon_{it}$
Jones total accruals model adjusted using ROA (Kothari et al., 2005)	$TA_{it} = \beta_0/ASSETS_{it-1} + \beta_1 \Delta SALES_{it}/ASSETS_{it-1} + \beta_2 PPE_{it}/ASSETS_{it-1} + \beta_3 ROA_{it-1}/ASSETS_{it-1} + \varepsilon_{it}$
Modified Jones total accruals model using ROA (Kothari et al., 2005)	$TA_{it} = \beta_0/ASSETS_{it-1} + \beta_1 [\![(\Delta SALES]\!]_{it} - \Delta ARit)/ASSETS_{it-1} + \beta_2 PPE_{it}/ASSETS_{it-1} + \beta_3 ROA_{it-1}/ASSETS_{it-1} + \varepsilon_{it}$
Production costs model (Roychowdbury, 2006)	$PROD_{it}/ASSETS_{it-1} = \beta_0 + \beta_1(1/ASSETS_{it-1}) + \beta_2(SALES_{it})/ASSETS_{it-1} + \beta_3(\Delta SALES_{it})/ASSETS_{it-1} + \beta_3(\Delta SALES_{it-1})/ASSETS_{it-1} + \varepsilon_{it}$
Discretionary expenses model (Roychowdbury, 2006)	$DISEXP_{it}/ASSETS_{it-1} = \beta_0 + \beta_1(1/ASSETS_{it-1}) + \beta_2(SALES_{it-1})/ASSETS_{it-1} + \varepsilon_{it}$

Table 3. Summary statistics

This table reports summary statistics for both real oil prices and oil price logarithmic transformation by showing mean (Mean), median (Median), standard deviation (SD), skewness (Skew.) and kurtosis (Kurt.). See Table 1 for the variables' definition.

Panel A: Real crude oil price						
Variables	Mean	Median	SD	Skew.	Kurt.	N
p_t	49.280	43.150	28.820	0.635	2.273	2509
$\bar{p}_t$	49.721	46.420	28.479	0.570	2.123	2509
$future_{pt}$	49.567	45.650	29.053	0.592	2.192	2509
Panel B: Natural logarithm of oil price						
p_t	3.715	3.765	0.620	1.805	-0.074	2509
$\bar{p}_t$	3.730	3.838	0.610	1.716	-0.069	2509
$future_{pt}$	3.718	3.821	0.625	1.703	-0.062	2509

Table 3. Summary statistics (continued)

This table reports both summary statistics and test of difference in means for the financial variables used in the empirical analyses at the industry level. The sample period ranges from 1986 Q1 to 2019 Q4. All variables are scaled by total assets. Table 1 contains the definitions of the variables. The test of difference in means is t-test; p-values are displayed in parentheses.

Variables	SIC code 1311			SIC code 2911			SIC 1311 – Sic 2911		Full sample			
	Mean	Median	SD	Mean	Median	SD	Diff. in means		Mean	Median	SD	N
TACC	-0.024	-0.049	0.372	-0.091	-0.098	0.172	0.0583^{***}	(3.84)	-0.040	-0.066	0.335	2.509
1/TA	0.834	0.003	3.435	0.103	0.000	0.858	0.756^{***}	(5.19)	0.651	0.001	3.021	2.509
PPE	0.987	0.783	1.074	1.164	1.169	0.439	-0.178^{***}	(-3.51)	1.031	0.943	0.958	2.509
ROA	-0.508	0.001	16.472	-0.090	0.012	1.027	-0.408	(-0.71)	-0.403	0.006	14.270	2.509
sale	0.154	0.136	0.135	0.231	0.214	0.145	-0.0913^{***}	(-15.04)	0.173	0.154	0.141	2.509
$\Delta sale_t$	0.008	0.002	0.045	0.002	0.003	0.043	0.000540	(0.26)	0.007	0.002	0.045	2.509
$\Delta sale_{t-1}$	0.005	0.001	0.040	0.006	0.005	0.031	-0.00257	(-1.41)	0.005	0.002	0.038	2.509
PROD	-0.642	-0.000	4.430	-0.009	-0.000	0.193	-0.589^{***}	(-3.34)	-0.483	-0.000	3.846	2.509
DISEXP	0.186	0.035	0.615	0.066	0.021	0.376	0.121^{***}	(4.71)	0.156	0.029	0.567	2.509

Table 4. Correlation coefficients

This table reports the Pearson's correlation coefficients for both dependent and explanatory variables included in the analyses. All variables are defined in Table 1.

	p_t	$\bar{p}_t$	σ_{pt}	E[p_t]	TACC	1/TA	Sales	PPE	$\Delta sale_t$	ΔS_{it}-ΔR_{it}	ROA	PROD
p_t	1											
$\bar{p}_t$	0.989***	1										
σ_{pt}	0.372***	0.455***	1									
E[p_t]	0.982***	0.995***	0.841***	1								
TACC	-0.046**	-0.051**	-0.039**	-0.049**	1							
1/TA	0.159***	0.168***	0.115***	0.168***	-0.06***	1						
$Sale_T$	0.012	0.002	-0.11***	-0.027	-0.028	-0.025	1					
PPE	-0.10***	-0.10***	-0.023	-0.11***	-0.033	0.034	0.024	1				
$\Delta sale_t$	-0.039**	-0.032*	-0.010	-0.036*	-0.12***	0.204***	0.359***	0.060**	1			
ΔS_{it}-ΔR_{it}	-0.001	-0.010	-0.09***	-0.014	0.073***	-0.031	0.732***	0.039*	0.215***	1		
ROA	-0.003	-0.002	0.011	-0.005	-0.046**	0.114***	0.006	0.086***	0.184***	-0.05**	1	
PROD	0.021	0.024	0.029	0.023	-0.040**	0.069***	0.011	0.033	0.117***	-0.021	0.528***	1

*** significance level <0.01; ** significance level <0.05; * significance level p<0.1.

Table 5. Accrual earnings management model augmented with WTI quarterly spot price, WTI average quarterly price and WTI quarterly volatility

This table reports the estimated coefficients obtained by running an FGLS estimation on the Modified Jones Model with the ROA (Kothari, 2005), augmented with the natural logarithmic of the WTI quarterly spot price in Column 1, with the WTI average quarterly price in Column 2 and with the WTI quarterly volatility in Column 3. The dependent variable is the total accruals. The analysis is on the full sample. All variables are defined in Table 1. Robust standard errors are contained in parentheses. ***, ** and * represent statistical significance at the 1%, 5% and 10% levels.

Variables	Column 1	Column 2	Column 3
p_t	-0.0216***		
	(0.0048)		
$\bar{p}_t$		-0.0223***	
		(0.00480)	
σ_{pt}			-0.0271***
			(0.00894)
1/TA	0.0224***	0.0225***	0.0221***
	(0.00345)	(0.00346)	(0.00359)
PPE	0.0231*	0.0252*	-0.00766
	(0.0139)	(0.0140)	(0.0105)
ΔS_t-ΔR_t	0.109***	0.109***	0.108***
	(0.0206)	(0.0206)	(0.0205)
ROA	0.0002	0.000223	0.000161
	(0.0005)	(0.000519)	(0.000517)
Obs.	2,509	2,509	2,509
N. of gvkey	170	170	170
Wald	92.64	93.89	80.39

Table 6. Real earnings management models augmented with WTI quarterly spot price, WTI average quarterly price and WTI quarterly volatility

This table reports the estimated coefficients obtained by running an FGLS estimation on real earnings management models augmented with with the WTI average price and the WTI quarterly price volatility. The analysis is on the full sample. Robust standard errors are contained in parentheses. ***, ** and * represent statistical significance at the 1%, 5% and 10% levels.

Variables	Column 1 Productions costs	Column 2 COGS	Column 3 Change in inventory	Column 4 Discretionary expenditures	Column 5 Productions costs	Column 6 COGS	Column 7 Change in inventory	Column 8 Discretionary expenditures	Column 9 Productions costs	Column 10 COGS	Column 11 Change in inventory	Column 12 Discretionary expenditures
p_t	0.00271***	0.00184**	-0.000214*	0.0188*								
	(0.000945)	(0.000913)	(0.000128)	(0.0107)								
$\bar{p}_t$					0.0027***	0.0020**	-0.00023*	0.0219**				
					(0.0009)	(0.0009)	(0.0001)	(0.0107)				
σ_{pt}									0.0003	0.0002	-0.0001**	0.0029
									(0.0003)	(0.0003)	(0.000)	(0.0025)
1/TA	-0.00416***	-0.00451***	-1.99e-05	0.140***	-0.0041***	-0.0045***	-1.55e-05	0.140***	-0.0042***	-0.005***	-3.59e-05	
	(0.000638)	(0.000599)	(9.36e-05)	(0.00564)	(0.0006)	(0.0006)	(0.000)	(0.0056)	(0.0006)	(0.0006)	(9.12e-05)	
Sale	0.674***	0.692***	0.0109***		0.673***	0.689***	0.0112***		0.700***	0.705***	0.0101***	
	(0.0163)	(0.0153)	(0.00233)		(0.0164)	(0.0154)	(0.00235)		(0.0127)	(0.0130)	(0.00174)	
$\Delta sale_t$	-0.137***	-0.0990***	0.00283		-0.136***	-0.0970***	0.00242		-0.156***	-0.108***	0.00188	
	(0.0293)	(0.0257)	(0.00660)		(0.0294)	(0.0258)	(0.0066)		(0.0287)	(0.0251)	(0.00659)	
$\Delta sale_{t-1}$	0.0138	-0.0115	0.0191***		0.0141	-0.0112	0.0189***		0.00208	-0.0224	0.0194***	
	(0.0306)	(0.0265)	(0.00719)		(0.0306)	(0.0265)	(0.00719)		(0.0302)	(0.0259)	(0.00715)	
LagSale				-0.0759				-0.0901				
				(0.127)				(0.127)				
Obs.	2,509	2,509	2,509	2,509	2,509	2,509	2,509	2,509	2,509	2,509	2,509	2,509
N. of gvkey	170	170	170	170	170	170	170	170	170	170	170	170
Wald	4848	5206	58.51	637.8	4829	5154	58.86	638.8	4201	4028	60.85	816.6

Table 7. Accrual earnings management model augmented with oil price variables
Results by SIC 1311 (exploration and production) and by SIC code 2911 (petroleum refining)

This table reports the estimated coefficients obtained by running an FGLS estimation on the Modified Jones Model with the ROA (Kothari, 2005), augmented with the WTI average price and the WTI quarterly price volatility. The dependent variable is the total accruals for all the models. Robust standard errors are contained in parentheses. ***, ** and * represent statistical significance at the 1%, 5% and 10% levels.

	SIC 1311 (exploration and production firms)			SIC 2911 (petroleum refining firms)		
Variables	**Column 1**	**Column 2**	**Column 3**	**Column 4**	**Column 5**	**Column 6**
p_t	-0.016***			0.0153**		
	(0.00505)			(0.00682)		
$\bar{p}_t$		-0.0175***			0.000562***	
		(0.0050)			(0.0001)	
σ_{pt}			-0.0055**			1.07e-05
			(0.002)			(0.00169)
1/TA	0.0227***	0.0228***	0.0218***	0.00546	0.00541	0.00354
	(0.0035)	(0.0035)	(0.0035)	(0.0130)	(0.0113)	(0.0115)
PPE	0.0161	0.0180	-0.0107	-0.119***	-0.0958***	-0.0199**
	(0.014)	(0.0150)	(0.010)	(0.0204)	(0.00827)	(0.009)
ΔS_t-ΔR_t	0.106***	0.106***	0.108***	-0.213***	0.109	-0.0743***
	(0.023)	(0.023)	(0.020)	(0.0813)	(0.0934)	(0.00643)
ROA	0.00050	0.000483	0.0002	0.118***	0.119***	0.130***
	(0.0005)	(0.0005)	(0.0005)	(0.0122)	(0.00926)	(0.00941)
Obs.	1,933	1,933	1,933	576	576	576
N. of gvkey	139	139	139	31	31	31
Wald	71.63	72.37	67.03	267.2	270	293.3

Table 8. Real earnings management model augmented with oil price variables
Results by SIC 1311 (exploration and production) and by SIC code 2911 (petroleum refining)

This table reports the estimated coefficients obtained by running an FGLS estimation on real earnings management models augmented with the WTI average price. Robust standard errors are contained in parentheses. ***, ** and * represent statistical significance at the 1%, 5% and 10% levels.

	SIC 1311 (exploration and production firms)				SIC 2911 (petroleum refining firms)			
Variables	**Column 1 Productions costs**	**Column 2 COGS**	**Column 3 Change in inventory**	**Column 4 Discretionary expenditures**	**Column 5 Productions costs**	**Column 6 COGS**	**Column 7 Change in inventory**	**Column 8 Discretionary expenditures**
p_t	0.0015**	0.0029**	-0.0004**	0.0171	-0.00216	-0.00029	0.0001	0.08830***
	(0.0007)	(0.0008)	(0.0002)	(0.0122)	(0.0015)	(0.0019)	(0.0002)	(0.0218)
1/TA	-0.0016***	-0.0030***	0.000	0.133***	-0.0314***	-0.0247***	-0.000394	0.312***
	(0.0004)	(0.0005)	(0.0001)	(0.0061)	(0.0037)	(0.00319)	(0.0010)	(0.0165)
Sale	0.641***	0.632***	0.0181***		0.837***	0.803***	0.00184	
	(0.0146)	(0.0172)	(0.00373)		(0.0213)	(0.0247)	(0.0036)	
$\Delta sale_t$	-0.0772**	-0.0533*	-0.0249***		-0.0753*	-0.129***	0.0446***	
	(0.0369)	(0.0318)	(0.00807)		(0.0386)	(0.0378)	(0.0135)	
$\Delta sale_{t-1}$	0.0734*	0.00425	0.00640		0.0414	0.0584	0.0322*	
	(0.0377)	(0.0318)	(0.00813)		(0.0514)	(0.0462)	(0.0182)	
LagSale				0.00583				-1.890***
				(0.141)				(0.259)
Obs.	1,933	1,933	1,933	1,933	576	576	576	576
N. of gvkey	139	139	139	139	31	31	31	31
Wald	5817	5817	74.75	499.2	4463	3766	35.02	439.3

Table 9. 2SLS – Accrual earnings management model augmented with oil exports to China

This table reports the 2SLS regression on the Modified Jones Model with the ROA (Kothari, 2005), including ExportChina, which is the instrumental variable for oil price. The first-stage regression is run at firm level. Firm fixed effects are included in the analyses. Robust standard errors clustered by firm are contained in parentheses. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels.

	Full Sample	SIC 1311 subsample	SIC 2911 subsample
Variables	**Column 1**	**Column 2**	**Column 3**
ExportChina	-0.0127**	-0.0145**	0.0241***
	(0.00589)	(0.00616)	(0.00926)
1/TA	0.0195*	0.0212*	0.00668
	(0.0114)	(0.0116)	(0.0146)
PPE	-0.00634	0.00953	-0.143***
	(0.0225)	(0.0253)	(0.0265)
ΔS_t-ΔR_t	0.101*	0.0996*	0.114
	(0.0557)	(0.0571)	(0.0985)
ROA	0.00145	0.00129	0.125***
	(0.00295)	(0.00305)	(0.0134)
Obs.	2,509	1,933	576
N. of gvkey	170	139	31

Table 10. GMM – Accrual earnings management models augmented with crude oil spot

This table reports the estimated coefficients obtained by running dynamic panel system GMM, lag (10) estimation on the Modified Jones Model with the ROA (Kothari, 2005), augmented with crude quarterly spot price. Tests for autocorrelation in levels (AR1) and differences (AR2) indicate the quality of the instrumental variables and Sargan's statistic is used to indicate whether the restrictions are overidentified. Robust standard errors clustered by firms are contained in parentheses. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels.

	Full Sample	SIC 1311 subsample	SIC 2911 subsample
Variables	**Column 1**	**Column 2**	**Column 3**
p_t	-0.009***	-0.009***	0.014***
	(0.003)	(0.004)	(0.002)
1/TA	0.020***	0.022***	0.005
	(0.002)	(0.002)	(0.006)
PPE	-0.021**	-0.012	-0.114***
	(0.009)	(0.011)	(0.007)
ΔS_t-ΔR_t	0.102***	0.100***	0.112**
	(0.019)	(0.021)	(0.052)
ROA	0.002***	0.001***	0.122***
	(0.000)	(0.001)	(0.005)
Obs.	2,509	1,933	576
N. of gvkey	170	139	31
Std.Er.Clustered by FIRM	YES	YES	YES
AR(1)	0.0001	0.0007	0.8080
AR(2)	0	1691	745.4
Sargan	1969	1060	275
N. of instruments	1192	1,293	432

Table 11. Accrual earnings management model augmented with expected WTI quarterly price

This table reports the estimated coefficients obtained by running an FGLS estimation on the Modified Jones Model with the ROA (Kothari, 2005), augmented with the expected value of the WTI quarterly price at t+1. The dependent variable is the total accruals for all the models. The analysis is on the full sample. Robust standard errors are contained in parentheses. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels.

	Full sample	SIC 1311 subsample	SIC 2911 subsample
Variables	**Column 1**	**Column 2**	**Column 3**
$E[p_t]$	-0.0124***	-0.0114***	0.00839***
	(0.0012)	(0.00123)	(0.00316)
1/TA	0.0389***	0.0403***	0.00918
	(0.0059)	(0.00595)	(0.0154)
PPE	-0.0253***	-0.0153***	-0.0597***
	(0.0044)	(0.00485)	(0.00872)
ΔS_t-ΔR_t	0.0973***	0.0892**	0.0619
	(0.0287)	(0.0360)	(0.0446)
ROA	0.00133	0.00132	0.112***
	(0.0017)	(0.00189)	(0.0227)
Obs.	2,509	1,933	576
N. of gvkey	170	139	31
Wald	1078.35	544.8	763.3

Table 12. Accrual earnings management model augmented with NYMEX WTI crude oil future

This table reports the estimated coefficients obtained by running an FGLS estimation on the Modified Jones Model with the ROA (Kothari, 2005), augmented with the NYMEX WTI crude oil future price (Contract 3). The dependent variable is the total accruals for all the models. Robust standard errors are contained in parentheses. Robust standard errors are contained in parentheses. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels.

	Full sample	SIC 1311 subsample	SIC 2911 subsample
Variables	**Column 1**	**Column 2**	**Column 3**
$future_{pt}$	-0.0216***	-0.0170***	0.0151**
	(0.0048)	(0.00505)	(0.0068)
1/TA	0.0224***	0.0227***	0.00544
	(0.0034)	(0.0035)	(0.0130)
PPE	0.0231*	0.0163	-0.119***
	(0.0139)	(0.0149)	(0.0204)
ΔS_t-ΔR_t	0.109***	0.106***	-0.210***
	(0.020)	(0.0239)	(0.0813)
ROA	0.000229	0.00049	0.118***
	(0.00052)	(0.0005)	(0.0122)
Obs.	2,509	1,933	576
N. of gvkey	170	139	31
Wald	92.67	71.74	267.6

Table 13. Accrual earnings management models augmented with WTI quarterly spot price from 2019 Q4 to 2020 Q2

This table reports the estimated coefficients obtained by running an FGLS estimation on quarterly data, augmented with the WTI quarterly spot price from 2019 Q4 to 2020 Q2. Robust standard errors are contained in parentheses. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels.

	Full sample				SIC 1311 subsample			
Var.	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8
P_{2020}	0.00199	0.00213*	0.00227*	0.00238*	0.00332**	0.00347***	0.00345***	0.00358***
	(0.00124)	(0.00123)	(0.00124)	(0.00124)	(0.00132)	(0.00131)	(0.00133)	(0.00131)
1/TA	-0.0429***	-0.0422***	-0.0433***	-0.0426***	-0.0434***	-0.0427***	-0.0435	-0.0428***
	(0.000864)	(0.000910)	(0.000895)	(0.000945)	(0.000886)	(0.000932)	(0.0009)	(0.0009)
Sales	4.097***	4.077***	4.101***	4.083***	4.229***	4.209***	4.2320***	4.2140***
	(0.177)	(0.175)	(0.184)	(0.182)	(0.182)	(0.181)	(0.0190)	(0.1885)
PPE	-0.269***	-0.275***	-0.324***	-0.325***	-0.332***	-0.338***	-0.3610***	-0.3625***
	(0.0732)	(0.0727)	(0.0795)	(0.0789)	(0.0769)	(0.0762)	(0.0827)	(0.0820)
ROA		0.00986**		0.00935**		0.00994**		0.0096**
		(0.00430)		(0.00429)		(0.00437)		(0.0043)
P_{2020}* 2020 Q1			0.00247* (0.00143)	0.00225 (0.00142)			0.0014 (0.0015)	0.00119 (0.0014)
P_{2020}* 2020 Q2			0.00253 (0.00512)	0.00224 (0.00509)			0.0092 (0.0052)	0.0006 (0.0051)
Obs	2,509	2,509	2,509	2,509	1,933	1,933	1,933	1,933