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Impairment of Assets: a Study in Global Crude-Oil Companies

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Abstract
Oil and gas exploration and production (E&P) is a typically capital-intensive activity, involves high risks and long investment maturity terms. These characteristics entail high asset values and difficulties to recover these capitalized values. Hence, the impairment test to check the possibility to recover these asset values is very important for this sector. In that context, the aim of this study was to undertake an analysis in order to identify how oil price and proven reserve variations are related to the impairment expenses attributed to oil E&P activities. An inverse relation was found between the impairment expenses attributed to E&P activities and the volume of discoveries and the net balance of reserve purchases and sales. The study did not confirm, however, that an inverse relation exists between the price and reserve volume and impairment expenses. The direct relation between production and impairment loss was not confirmed either.

Key words: Impairment; IAS 36; SFAS 144; Oil and Gas; Accounting for the crude-oil sector.

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1. INTRODUCTION

Each industrial sector displays its own operating characteristics in business and accounting practices, but a sector as rich in industrial operation, management and accounting particularities as the oil sector is rare (IJIRI, 1979, *apud* WOLK, FRANCIS and TEARNEY, 1984).

A range of theoretical and technical problems characterizes accounting for the crude-oil sector and consequently its disclosure, which historically refer to analysts and investors' impossibility to use financial statement data to value these companies' equity. This reveals the need for additional financial and operational information on oil exploration and production activities (e.g. SFAS 69 and Regulation S-X 4-10).

The problems accounting faces in oil and gas companies derive from this industry's singular characteristics: 1) high risk of finding dry wells; 2) long period between the discovery of reserves and their realization in the form of income or cash; 3) dissociation between expenditures (investments), revenues and reserves (returns); and 4) the strategic importance the commodity gained in international markets, and mainly as an energy source for countries (CLÔ, 2000).

These characteristics can be observed in any industrial phase, but gain evidence when its main segment (activity) is observed: oil and gas exploration and production (GALLUN, STEVENSON and NICHOLS, 1993). That activity registers the highest asset values and gains (profits) in an oil company.

According to Godoy (2004), as a result of these singular characteristics, oil and gas E&P face difficulties to recover the invested – capitalized amounts. Therefore, asset (investment) value impairment tests gain enhanced importance for the sector, and mainly for E&P (GALLUN; STEVENSON; NICHOLS, 1993; GODOY, 2004; BROCK; CARNES; JUSTICE, 2007).

In Brazil, as a result of the approval of Law 11.638, enacted on December 28th 2007, deriving from Bill 3.741/2000, impairment tests became compulsory for the amounts registered in corporations and large companies' fixed assets.

At bottom, the impairment test aims to check the assets' impairment, which means to identify assets whose expected cash flows substantially decrease due to adverse situations. Once identified, these assets can no longer be disclosed on the balance sheet at their original values, as they no longer demonstrate the ability to produce future economic benefits (STICKNEY; WEIL, 2001).

Today, the main standards guiding the application of the impairment test are: a) SFAS 144 – Accounting for the Impairment or Disposal of Long-Lived Assets, issued by the Financial Accounting Standards Board (FASB); b) IAS 36 – Impairment of Assets, by the International Accounting Standards Board (IASB); and c) **CPC 01 – Impairment of Assets, by the Brazilian Accounting Pronouncements Committee (CPC)**.

For oil companies, the range of standards increase as, besides following the impairment standards applied to companies in general, they are also obliged to comply with the sector's specific standards.

According to the Brazilian standards, besides the orientations in CPC 01, oil companies also have to comply with 34 – Exploration and Evaluation of Mineral Resources. For companies that adopt IASB standards, besides IAS 36, companies have to comply with IFRS 6 – Exploration for and Evaluation of Mineral Resources.

For companies tied by North American standards, the rules vary according to the tested asset's characteristics and to the expenditure capitalization method the company adopts. For assets associated with non-proven oil and gas properties, the rule is available in SFAS 19 - Financial Accounting and Reporting by Oil and Gas Producing Companies. For assets associated with proven oil and gas properties, the rule depends on the adopted expenditure capitalization method: companies using the Full Cost (FC) method have to use Regulation S-X Rule 4-10 - Financial Accounting and Reporting for Oil and Gas Producing Activities Pursuant to the Federal Securities Laws and the Energy Policy and Conservation da Securities and Exchange Commission (SEC); companies adopting the Successful Efforts (SE) method have to follow FASB standard SFAS 144.

Independently of the standard followed, the adverse situations that cause impairment are common in oil companies, as they are directly related with the inherent characteristics of the assets used to explore and produce oil and gas. These are: a) alterations in commodity (oil and gas) prices, and b) change

in estimated oil and gas reserves, which in turn are affected by reviewed estimations, improvements in the recovery of reserves, discoveries, purchases and sales of reserves and production. These changes can be considered variables that affect the calculation of the asset's recoverable value, and which consequently affect impairment losses (ALCIATORE; EASTON; SPEAR, 2000; BROCK, CARNES; JUSTICE, 2007).

In view of the above, this study raises the following question: What is the relation between oil prices and proven reserve volumes and their changes on the one hand and impairment losses attributed to oil and gas E&P assets in oil companies, and what are the differences between the main standards addressing impairment (SFAS 144, IAS 36 and CPC 01)?

Thus, the aim of this study was to undertake an analysis in order to identify how oil price and proven reserve variations are related to the impairment expenses attributed to oil and gas E&P activities in oil companies.

In addition, a survey is developed about the main FASB (SFAS 144), IASB (IAS 36) and CPC (CPC 01) pronouncements that address asset devaluation, disclosing their main divergences.

To answer the research question and thus reach the proposed aims, this study has been structured as follows: item 2 addresses conceptual aspects related to an asset's impairment loss, SFAS 144, IAS 36, CPC 01 and presents a comparative analysis of the standards. In item 3, the empirical research method is presented; in item 4, proposals related to the empirical evidence are raises; the results are presented in item 5 and; finally, in item 6, the final considerations.

2. THEORETICAL FRAMEWORK

2.1 The asset and its Impairment

In view of the economic value concept, independently of any legal aspect, companies should periodically assess their assets' impairment. (REISTEM; LANDER, 2004; MARTINS, 2008).

The impairment test is a procedure that should theoretically be applied to all balance sheet assets. Its method was already applied unknowingly to some assets, like inventories, when these were valued at their cost or market value, the lowest of both; and accounts receivable, when a provision for credit adjustment was acknowledged at its realization value or the traditional allowance for doubtful accounts, formerly doubtful debtors (MARTINS; SANTOS, 2008; ERNEST & YOUNG, 2009).

From a valuation perspective, the aim of impairment is to adapt the book value to the asset's ability to produce future benefits, i.e. asset valuation is practiced through the fair value (RIELD, 2004).

Perhaps the negative aspect is the fact that impairment practices raise significant disclosure challenges, as they imprint some degree of subjectivity on financial statements, considering that they demand judgments and estimates (RIELD, 2004).

In the attempt to approximate the management reports that analyze the economic feasibility of investments to the information disclosed to the market, accounting standardization entities issued some accounting standards on the impairment test.

2.2 SFAS 144: Accounting for the Impairment or Disposal of Long-lived Assets

According to SFAS 144, impairment is a condition that exists when the registered amount for an asset or group of assets is higher than its fair value. The registered amount of an asset or group of assets is considered non-recoverable if it exceeds the sum of expected non-discounted net cash flows, deriving from the use and eventual sale of the asset.

In that sense, impairment is determined by the comparison between the asset's (or asset group's) book values and the projected non-discounted net cash flows for that asset. In other words, when the first is higher than the second, an impairment loss should be recognized.

According to SFAS 144, assets or groups of assets should be tested during their useful life when events or changed circumstances indicate that their book value may not be recoverable: (i) a significant decrease in the market price of the asset (or group of assets); (ii) a significant adverse modification in the extent or way in which the asset (or group of assets) is used, or a modification in its physical conditions; (iii) a significant

adverse modification in legal factors, regulations by control entities or in the business environment, which could affect the asset value; (iv) accumulated costs significantly higher than the initially established amount for the purchase or construction of the asset (or group of assets); (v) current operating or cash flow losses, combined with a history of or projected losses resulting from the use of an asset or group of assets and (vi) more than 50% of expectation that an asset (or group of assets) will be sold or written off before its estimated useful life.

These orientations gain complexity when considering the existence of a group of assets (REINSTEIN; LANDER, 2004). SFAS 144 defines group of assets as the smallest aggregation unit of goods that are capable of producing cash inflows and outflows independently from the company's other assets (or groups of assets). These main join some assets only, without constituting a "reporting unit", or may even consider the company as a whole.

Thus, when recognizing and measuring the impairment loss, companies should group the assets with other assets and liabilities until the lowest level for which cash flows are identified that are largely independent from other assets and liabilities' cash flows, thus constituting a group of assets (REINSTEIN; LANDER, 2004).

In this situation, SFAS 144 defines that the remaining useful life of the asset group will be based on the remaining useful life of the primary asset in the group. A primary asset is that asset without which the asset group will be unable to produce independent future cash flows, or whose individual book value is very representative in the total value of the group that is tested.

Finally, the impairment loss value is defined by the difference between the book value and the sum of the discounted cash flows. This value is transferred to the income for the period the test relates to. The accounting effects of this loss produce changes in the respective assets' original accounts, disclosing the adoption of the new book value, adjusted by the impairment loss, as the base for future depreciations/amortizations, as well as for future impairment tests (REINSTEIN; LANDER, 2004). SFAS 144 also defines that, once disclosed, reverting an impairment loss is prohibited.

Regarding disclosure, the following should be included in notes to the financial statements, including the period when the impairment loss is recognized: a) description of the asset (or group of assets) that suffered the impairment loss, as well as the facts and circumstances justifying the loss; b) the value of the impairment loss and the income statement account including the loss, if not presented in another report; c) the method or methods used to determine the fair value, and d) if the asset (or group of assets) subject to the loss is a component of an operating segment, SFAS 144 indicates that the orientations in SFAS 131 – Disclosures about segments of an enterprise and related information have to be respected.

2.3 IAS 36 – Impairment of Assets

IAS 36 aims to define procedures to guarantee that assets are not registered at a higher book value than the value that can be recovered through use or sale. If evidence exists of impaired assets in the future, the entity should apply the test to check the possible loss and, if identified, the devaluation should be recognized through the constitution of an allowance for impairment losses.

The recoverable value of an asset or a cash-generating unit is the highest value between the net sales value and the value in use; the value in use is the present value of estimated future cash flows.

The orientations of IAS 36 address the accounting treatment of impairment for almost all asset types, including fixed and intangible assets and goodwill. It does not apply to some assets though, as specific standards exist for their disclosure and measurement.

At the end of each period, the entity should evaluate whether there is any sign that the asset has lost economic substance. If any sign exists, the recoverable amount of the asset needs to be estimated. As asset devaluation indicators, the standard presents an exhaustive list of information sources, classified into external and internal sources.

The main external information that should be observed is: a) whether the market value of an asset decreased more than expected, in function of the time and its use; b) whether significant changes took place in the technological, market, economic or legal environment that affect the entity's asset; c) if interest

rates increased to the extent that they affected the discount rate used to calculate the value of the asset in use (cash flow); and d) if the net book value of the assets is higher than its capitalized market value.

Internal information includes: a) evidence proving that the asset is obsolete or damaged; b) significant changes in the way the asset is used, including its shut down; and c) indication of a higher-than-expected drop in an asset's economic performance, evidenced in an internal report.

Independently of these indications, the standard prescribes that the entity should annually test the loss of economic substance for intangible assets of undefined useful life and for the goodwill acquired in a business combination.

In general conditions, the standard states that the recoverable value has to be calculated for an individual asset. If the recoverable value of an individual asset cannot be calculated, however, due to the fact that the cash flows it generates depend on the cash flows generated by other assets, the recoverable value has to be determined for the cash-generating unit (CGU).

IAS 36 defines CGU as the smallest identifiable group of assets that generates cash inflows, which are largely independent from the cash inflows of other assets or asset groups.

For oil and gas companies and, hence, for E&P assets, the definition of cash-generating unit is regulated in IFRS 6 – Exploration for and Evaluation of Mineral Resources. In that standard, each cash-generating unit or group of units an E&P asset is attributed to should not be larger than a business segment, determined according to IFRS 8 - Operating Segments.

After measuring the recoverable value of an asset (or a CGU), if lower than its book value, it should be impaired. This reduction represents a devaluation loss and, hence, impairment exists. The asset's devaluation loss should be disclosed in the income, except for those assets subject to revaluation, whose losses will be registered in revaluation reserves in the equity group.

To check whether a possible asset value loss exists, the net sales value or value in use of that asset needs to be determined. If any of both exceeds its book value, however, that already characterizes the non-existence of a loss, so that both other values do not have to be determined, as the benefits deriving from the use or sale of the asset are higher than the value the entity has registered.

In case a CGU is identified, the value of the loss should primarily be allocated to reduce the registered amount of any goodwill attributed to that loss, and then to the other assets in the CGU on a *pro rata* base, based on the registered values of each asset.

Another important point to be mentioned is the possibility of reverting a devaluation loss. On each report date, the entity has to evaluate whether there are any signs that a devaluation loss, recognized in previous periods for an asset, may no longer exist or have dropped. If any sign exists, the entity should estimate a new recoverable value for that asset.

In case of reversal, the standard also highlights facts that may occur and indicate a need for reversal. These are also called "information sources" and divided into external and internal sources.

The following are mentioned as information sources external to the entity: a) whether the market value of the asset significantly increased during the period, b) whether significant changes occurred or will occur in the economic, legal and technological environment the company operates in, so as to entail favorable effects, and c) if the market interest rates significantly dropped during the period, to the extent of being capable of changing the discount rate used to calculate the asset's value in use.

The internal sources cited are: a) whether significant changes occurred in the way the asset is used and whether this change entailed favorable effects for the entity, and b) if internal reports exist that indicate improvements in the good's economic performance.

This rise in the book value of an asset, when it can be attributed to the reversal of a devaluation loss, should not exceed the book value that would have been determined, net of depreciation, amortization or depletion, in case no devaluation had been disclosed in earlier periods. Any increase in the book value of an asset, superior to its book value, is considered a revaluation. The reversal of impairment losses should immediately be disclosed in the income, unless the asset is registered at a revalued amount, which in this case will be disclosed under revaluation reserves in the equity group.

Based on the operations performed related to the impairment loss, the main information the entity is to disclose for each asset class is: a) the value of the losses and reversals, disclosed in the income, and the line in which they were included; b) the events and circumstances that led to the disclosure or reversal of the loss; c) a description of the cash-generating unit (if that is the case) and d) the valuation method used to determine the recoverable value of the asset or a CGU: net sales value or value in use.

2.4 CPC 01: Impairment of Assets

In general, the international and Brazilian accounting standards, although texts differ, present the same orientations. The aim of convergence is attended to.

The main difference refers to disclosure. The Brazilian accounting standard does not establish specific disclosures for different operating segments. The international standard, through IFRS 8 – Operating Segments, defines a range of required disclosures for entities with more than one business segment and geographical segments.

It should be highlighted that the standard mentions concepts that are uncommon in Brazilian accounting: fair value; accounting treatment of intangible assets and operating segments. Therefore, obstacles to its implementation and significant impacts in Brazilian companies' financial statements are expected to occur.

2.5 Comparative Analysis of the main Impairment standards

The first main difference among the standards is the range of assets targeted by losses. The international and Brazilian standards extend to intangible assets and goodwill, the latter of which the FASB addresses in a specific standard (SFAS 142). For the sake of this research, however, the standards converge in terms of their applicability to the E&P assets of integrated oil companies that adopt the successful efforts capitalization method.

According to IAS 36 and CPC 01, the calculation of the discounted future cash flow is used for the determination and verification of the impairment loss, using the value in use. According to SFAS 144, on the other hand, the loss is determined by the excess non-discounted future cash flow over the book value, but its value is verified by confronted the discounted future cash flow with the book value. This indicates that the North American standard is more conservative than the IASB and CFC standards.

According to SFAS 144, impairment losses are permanent, so that their reversal in subsequent periods are not permitted. IASB and CFC, on the other hand, permit the reversal of impairment losses, in case of changes in the premises that generated that loss, when the recovery value should recompose the asset until the limit of its original value. This reversal should not be mixed up with the revaluation of goods, currently prohibited in Brazil.

In view of this analysis, it is verified that, despite considerable similarities, the differences observed among the standards compromise the accounting information quality and distort the instrument's true objective – to guarantee that the accounting records picture the value of the future economic benefits the entity's assets generate (AMPOFO; SELLANI, 2005). (Figure 1)

Differences among accounting standards for asset impairment test			
Standardizer	**FASB**	**IASB**	**CPC**
Topics	**SFAS 144 (August 2001)**	**IAS 36 (April 1998)**	**CPC 01 (September 2007)**
Test Range	Long-lived assets held for sale and use, including proven oil and gas reserves that adopt the successful efforts method. Does not apply to goodwill, intangible assets, financial assets, deferred taxes and non-proven oil and gas properties accounted for by the successful efforts method.	Almost all types of assets, including fixed assets, intangible assets and goodwill.	Applies to all relevant assets related to industrial, commercial, agricultural, mineral, financial, service activities and others. Extends to assets in financial statements used for the sake of equity accounting and complete or proportional consolidation. Also includes assets accounted for at their revalued value.

Disclosure	• Description of the asset (or group of assets) that suffered an impairment loss, as well as the facts and circumstances that justify the loss. • The amount of the loss and the income statement account it was included in. • Fair value determination method. • If the asset (or group) that suffered the loss is part of an operating segment, respect orientations in SFAS 131 – Disclosures about segments of an enterprise and related information.	• The amount of the losses and reversals disclosed in the income and what line in the statement they were included in. • Events and circumstances that led to the recognition or reversal of the loss. • A description of the cash-generating unit (if that is the case). • The valuation method to determine the recoverable value. • If the asset (or group) that suffered the loss is a component of an operating segment, respect orientations in IFRS 8: Operating Segments.	• The amount of the losses and reversals disclosed in the income and what line in the statement they were included in. • Events and circumstances that led to the recognition or reversal of the loss. • A description of the cash-generating unit (if that is the case). • The valuation method used to determine the recoverable value of the asset or of a cash-generating unit.
Recoverable Value	Sum of expected non-discounted cash flows deriving from the use and possible sale of the asset.	Highest between net sales value of an asset or its value in use.	Idem IAS 36.
Loss Determination	Comparison between book value of the non-discounted cash flow produced by the use or possible sale of the asset. An impairment loss will occur when the book value is higher than these non-discounted cash flows.	Comparison between book value and recovery value (highest between the value in use or the net sales value). A loss will occur when the book value is higher than the recoverable value.	Idem IAS 36.
Value of the Loss	Difference between the book value and the discounted cash flow deriving from the use or possible sale of the asset.	Difference between the book value and the recovery value (highest between the value in use or the net sales value).	Idem IAS 36.
Accounting treatment	Directly reduces the book value of the asset, as a counterpart to an operating loss in income determination.	Constitution of an allowance for impairment losses, as a counterpart to a revaluation reserve (if the asset is revalued), and an expanse in the income determination (if the asset is not revalued or the revaluation reserve balance is insufficient).	Idem IAS 36.
Reversal of Loss	The reversal of a previously disclosed loss is prohibited.	The reversal is permitted up to the limit of the book value the asset would have if the loss had not been disclosed previously.	Idem IAS 36.

Figure 1: Differences between Accounting Standards for the Impairment Test

Source: Elaborated by the authors

3. METHOD

In order to disclose and analyze the main differences between international and North American accounting standards, the relevant aspects from each of the respective pronouncements were highlighted.

To analyze how the main selected variables are related to the impairment expense, the annual reports 10-K, 20-F e 40-F were consulted for 19 integrated oil and gas companies listed on the New York Stock Exchange (NYSE), considering the impairment test of proven reserves in companies that adopt the successful efforts capitalization method – companies within the scope of IAS 36 and SFAS 144.

The impairment was delimited to proven properties because these are an oil exploration and production company's main assets. Companies that adopt the successful efforts capitalization method were chosen because these represent a majority and are also the largest companies in the sector.

The following companies were consulted: Chevron, ConocoPhillips, Exxon Mobil, Hess, Marathon and Murphy (USA), Petro-Canada and Suncor (Canada); BP (United Kingdom); China Petroleum and PetroChina (China); ENI (Italy); Royal Dutch Shell (The Netherlands); StatoilHydro (Norway); Total (France); Repsol (Spain); Sasol (South Africa); YPF (Argentina); Petrobras (Brazil).

Initially, the term determined for data collection refers to reports covering the period from 2002 to 2008. This time interval was defined based on the validity of SFAS 144, issued in August 2001 and required for financial years as from 2002. Not all companies had their reports filed at the NYSE for 2002 through, so that they were not subject to SEC requirements. Therefore, for the sake of a more standardized sample, reports were surveyed as from 2003, resulting in 19 companies, six years of analysis for each and 114 observations.

After defining the sample, the values of the following variables were surveyed for each company in each of the years: total impairment expense; impairment expenses attributes to the E&P assets (DIE&P); proven reserve volume (RP); production volume (PROD); discovery volume (DESC); review volume (REV); volume of recovery improvements (MELH); purchase volume (COMP); sales volume (VEND); and oil sales price (PREÇO_PETRO).

Amounts for the variables related to the oil sales prices and impairment expense were surveyed in dollars.

The values for the variables related to oil volumes were surveyed in barrels (oil); and in feet cubed for gas volumes. The, the gas volumes were transformed into "barrels of oil equivalent" (boe). Each barrel of oil corresponds to approximately 6,000 feet cubed of gas (energy content equivalent - British Thermal Unit). After that transformation, the gas variables were added up to the oil equivalent variables.

Then, the variables "discoveries", "reviews" and "recovery improvements" were added up to constitute a single variable (DESC). At bottom, these three variables represent an increase in the reserves obtained through efficiency gains – new reserves. This procedure is in accordance with SFAS 69 orientations. The pronouncement permits the disclosure of these variables in combination with Discoveries in case of insignificant values. These variables actually represent changes in reserve volumes, whether because of new discoveries ("discoveries"), new information that altered previous reserve valuation estimates ("reviews") or operating improvements in the reserve recovery process ("recovery improvements"). All of these derive from the access to new information the company did not master earlier (GALLUN, STEVENSON and NICHOLS, 1993).

Finally, the difference was calculated between "oil and gas purchase" and "oil and gas sale" variables, with a view to obtaining a net value (COMP_VEND). This is justified by the fact that these operations (purchase and sale of reserves) are not recurrent, as they are not part of the analyzed companies' aim – exploration and production.

With this information at hand, the normality of the data was tested using Kolmogorov-Smirnov's test, and values showing normal distribution were submitted to Pearson's parametric correlation test (which presupposed a bivariate normal population), which non-normal distributions were submitted to Spearman's non-parametric correlation test.

For the sake of the analysis, correlation coefficients were calculated for the 19 selected companies, each covering a period of six years. The results were then evaluated jointly and did not remain restricted to each company's individual results.

It is also highlighted that the objective of calculating correlation coefficients is not related to the formulation of regression models aimed at predicting impairment expenses. The intent is to identify indications of the surveyed variables' behaviors, with a view to inferences about the factors that influence the amount of impairment expenses linked with the E&P segment.

4. RESEARCH PROPOSALS

In view of the problem exposed and the review of concepts and standards that was presented, two basic proposals are raised, besides three others that add up to the second basic proposal:

Proposal 1: Oil prices and impairment expenses should display opposite behaviors.

Proposal 2: The reserve volumes and impairment expenses should display opposite behaviors.

Proposal 2.1: The production volumes and impairment expenses should display equal behaviors.

Proposal 2.2: The discovery volumes and impairment expenses should display opposite behaviors.

Proposal 2.3: The result of the difference between the sold and purchased oil and gas volumes and impairment expenses should display opposite behaviors.

5. EMPIRICAL EVIDENCES OF IMPAIRMENT IN THE CRUDE-OIL SECTOR

Considering the 19 companies selected for the sample, including six years for each company, 114 financial reports were consulted. Twelve (11%) of these were type 40-F; 66 (58%) type 20-F; and 36 (32%) type 10-K.

Regarding the consolidation of the financial statements, 76 (67%) were consolidated in US GAAP and 38 (32%) in IFRS. This reveals that most sample companies consist of foreign private securities and prefer the North American standards to consolidate their financial statements.

Considering the 114 companies-year, the means corresponded to 270,924,441 dollars in total impairment and 119,828,085 dollars of impairment attributed to the E&P segment.

The highest impairment value disclosed was 2,455 million dollars, for PetroChina in 2008, justified as including 620 million E&P assets and 1,835 million in general equipment and machinery. In the same year, a negative review of 467,833,333 boe was disseminated in the total volume of the company's proven reserves. Also, a growth trend is highlighted in the production figures of the oil and gas company.

The lowest value came from YPF, equaling 658,762 dollars in 2005. This value was fully attributed to the E&P segment and was also the lowest value disclosed for that segment. In the same year, the company reached 2,351,749,489 boe in proven reserves, the highest volume in the study period.

BP attributed the highest impairment value to the E&P segment in 2008 (observe the effect in Graph 1), corresponding to 1,186 million dollars. The company mainly attributes this value to impairments a) in oil and gas properties in the Gulf of Mexico, equaling $270 million, provoked by decreasing reserve reviews; b) in E&P assets in Vietnam, equivalent to $210 million, as a result of BP's decision to withdraw from exploration activities in the area; c) in oil and gas properties in Egypt, totaling $85 million, provoked by cost increases; and d) in other individually insignificant assets that caused a $104-million loss (as the company disclosed). Also, the company's negative review in 2008 is registered, equaling 593 billion feet cubed in gas reserves.

Table 1 presents the mean impairment expenses across the study period. DI_TOTAL and DI_EP refer to Total Impairment Expenses disclosed by the company and Impairment Expenses attributed to E&P assets, respectively. Therefore, the variable DI_EP/DI_TOTAL represents the share of impairment expenses attributed to E&P assets in the company's total impairment expenses.

Table 1: Mean Impairment (in US$)

NAME	DI_TOTAL	DI_EP	DI_EP/DI_TOTAL
BP	1,085,833,333	566,333,333	52%
Chevron	340,000,000	133,000,000	39%
China Petroleum	430,730,006	178,543,090	41%
ConocoPhillips	566,166,667	299,166,667	53%
ENI	304,312,212	177,316,444	58%
Exxon Mobil	–	–	–
Hess	91,000,000	36,500,000	40%
Marathon	502,000,000	24,000,000	5%
Murphy	14,990,750	2,800,000	19%
Petro-Canada	59,055,114	59,055,114	100%
Petrobras	183,666,667	138,833,333	76%
PetroChina	640,799,873	299,510,277	47%
Repsol	118,302,696	76,341,597	65%
Royal Dutch Shell	808,333,333	265,833,333	33%
Sasol	61,610,899	13,108,335	21%
StatoilHydro	335,899,689	283,572,928	84%
Suncor	7,995,335	7,995,335	100%
TOTAL	173,535,605	90,357,139	52%
YPF	26,204,197	26,204,197	100%

Source: Elaborated by the authors

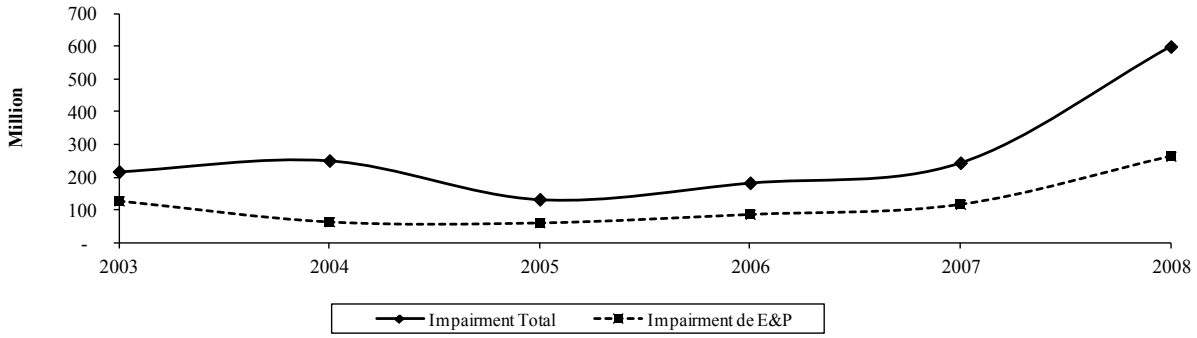
Although PetroChina was responsible for a company's highest total impairment in absolute values, on average, BP was responsible for that landmark, which also registered the highest average attributed to the E&P segment. This is justified by the fact that, in 1008, PetroChina registered a sporadic impairment value, against a relatively low average of 277,797 thousand dollars in impairment in previous years.

Suncor registered the lowest mean impairment value, while YPF registered the lowest absolute value. Specifically for the E&P segment, Murphy attributed the lowest mean value. YPF was also responsible for that landmark in absolute figures.

As for the share of E&P impairment expenses in companies' total impairment expenses, Marathon's low means and Petro-Canada, Suncor and YPF's high mean percentages are highlighted, which on average attributed 100% of their impairment expenses to the E&P segment.

It is also emphasized that, during the study period, Exxon Mobil did not register any impairment expense.

The mean impairment expenses were also analyzed year by year for the 19 companies. Graph 1 presents the companies' mean total and E&P impairment expenses.



Graph 1: Annual Mean Impairment Expenses

Source: Elaborated by the authors

Each of the 19 companies was considered to analyze the relations between the selected variables and impairment expenses, with six years each (n = 6); and each of the variables for the 114 companies-year. Statistical significance was not considered, as the sign of the correlation coefficient was emphasized in order to identify behaviors among the variables.

Tables 2 and 3 summarize the presented data. In Table 2, the correlation coefficients between the impairment expenses and study variables are presented – including oil price, proven reserves, discoveries, production and balance between reserve purchases and sales, respectively. The coefficients in Table 2 printed in grey indicated behavior in accordance with the presented proposals.

Table 2: Correlation Coefficients

NAME	DI X PREÇO_PETRO	DI X RP	DI X DESC	DI X PROD	DI X COMP_VEND
BP	0.22	0.70	0.50	0.57	0.66
Chevron	-0.45	0.63	0.49	-0.40	0.45
China Petroleum	0.64	0.52	-0.25	-0.68	-
ConocoPhillips	0.79	0.27	-0.41	-0.59	-0.69
ENI	0.45	0.33	-0.50	-0.18	-0.45
Exxon Mobil	-	-	-	-	-
Hess	0.31	0.62	0.63	-0.52	-0.58
Marathon	0.68	-0.43	-0.25	-0.45	0.30
Murphy	-0.22	0.70	-0.23	0.21	-0.44
Petro-Canada	0.60	-0.25	-0.35	-0.25	0.42
Petrobras	0.71	-0.44	-0.33	0.65	-0.37
PetroChina	0.62	0.43	-0.21	-0.58	-
Repsol	0.00	-0.29	-0.70	-0.40	-0.54
Royal Dutch Shell	-0.33	0.23	-0.19	-0.37	-0.65
Sasol	0.72	0.34	-0.37	-0.62	-
StatoilHydro	0.45	0.68	0.51	-0.61	-0.45
Suncor Energy	-0.84	-0.51	-0.27	0.52	-0.34
TOTAL	0.59	-0.69	-0.67	0.20	-0.38
YPF	0.19	-0.22	0.68	0.24	-0.66

Source: Elaborated by the authors

Table 3 complements Table 2 and should be understood as follows: cells with the letter Y represent those cases in which the relation between the variable and impairment expenses followed the formulated proposal. Cells with the letter N, then, represent those cases in which the relation between the variable and impairment expenses was not in accordance with the formulated proposal. The left and lower margins show the quantity and percentage of Y and N in the sample.

Table 3: Adherence of the Results to the Proposals

NAME	DI X PREÇO_ PETRO	DI X RP	DI X PROD	DI X DESC	DI X COMP_ VEND	Y	N	Y (%)	N (%)
BP	N	N	Y	N	N	**1**	**4**	**20%**	**80%**
Chevron	Y	N	N	N	N	**1**	**4**	**20%**	**80%**
China Petroleum	N	N	N	Y	-	**1**	**3**	**25%**	**75%**
ConocoPhillips	N	N	N	Y	Y	**2**	**3**	**40%**	**60%**
ENI	N	N	N	Y	Y	**2**	**3**	**40%**	**60%**
Exxon Mobil	–	–	–	–	–	**0**	**0**	–	–
Hess	N	N	N	N	Y	**1**	**4**	**20%**	**80%**
Marathon	N	Y	N	Y	N	**2**	**3**	**40%**	**60%**
Murphy	Y	N	Y	Y	Y	**4**	**1**	**80%**	**20%**
Petro-Canada	N	Y	N	Y	N	**2**	**3**	**40%**	**60%**
Petrobras.	N	Y	Y	Y	Y	**4**	**1**	**80%**	**20%**
PetroChina	N	N	N	Y	–	**1**	**3**	**25%**	**75%**
Repsol	Y	Y	N	Y	Y	**4**	**1**	**80%**	**20%**
Royal Dutch Shell	Y	N	N	Y	Y	**3**	**2**	**60%**	**40%**
Sasol Limited	N	N	N	Y	–	**1**	**3**	**25%**	**75%**
StatoilHydro	N	N	N	N	Y	**1**	**4**	**20%**	**80%**
Suncor.	Y	Y	Y	Y	Y	**5**	**0**	**100%**	**0%**
TOTAL.	N	Y	Y	Y	Y	**4**	**1**	**80%**	**20%**
YPF	N	Y	Y	N	Y	**3**	**2**	**60%**	**40%**
Y	5	7	6	13	11				
N	13	11	12	5	4				
Y (%)	**28%**	**39%**	**33%**	**72%**	**73%**				
N (%)	**72%**	**61%**	**67%**	**28%**	**27%**				

Source: Elaborated by the authors

For the sake of a better understanding, the results are presented for each of the study proposals.

- **Proposal 1:** Out of 18 companies in which impairment losses were disclosed (Exxon Mobil did not), in only five companies, 28%, the relation between the oil price and impairment expense variables was in accordance with proposal 1. These were Chevron, Murphy, Repsol, Royal Dutch Shell and Suncor.

- **Proposal 2:** In 39% of the companies, the relation between proven reserves and impairment expenses behaved according to proposal 2 - Marathon, Petro-Canada, Petrobras, Repsol, Suncor, TOTAL and YPF.

- **Proposal 2.1:** In eight out of 18 companies who presented impairment expenses, the production volume was positively (similarly) related with impairment expenses, i.e. in 33% of events - BP, Murphy, Petrobras, Suncor, TOTAL and YPF.

- **Proposal 2.2:** The discovery variable behaved according to proposal 2.2 in 13 out of 18 companies. Hence, it can be inferred that, in 72% of the sample companies, the discovery volume was inversely related with impairment expenses. The companies are: China Petroleum, ConocoPhillips, ENI, Marathon, Murphy, Petro-Canada, Petrobras, PetroChina, Repsol, Royal Dutch Shell, Sasol, Suncor and TOTAL.

- **Proposal 2.3:** The net difference between oil and gas reserve purchases and sales behaved according to the proposal in 11 out of 15 cases, 73%, which means that, as the difference (purchase – sale) increased, the impairment expense dropped – ConocoPhillips, ENI, Hess, Murphy, Petrobras, Repsol, Royal Dutch Shell, StatoilHydro, Suncor, TOTAL and YPF.

Based on the presented results, the variables that best behaved according to the proposals were discoveries (DESC), 72%, and net oil and gas purchases (COMP_VEND), 73%.

Only 15 companies disclosed the COMP_VEND variable in their reports, which showed a strong relation with impairment expenses and a weak relative influence on the variation in proven reserves in the companies under analysis.

Oil reserves are discovered as a consequence of exploration; the production of these reserves usually starts after the discovery and ends many years later, when the well or field is abandoned. Hence, for companies that explore and produce oil, the discovery of a new field is the most important economic factor in the activity. In fact, it represents the main economic event in this sector, obviously, even more than the accounting income and revenues deriving from oil and gas sales as, when the existence of economically feasible reserves is confirmed, the production process starts. The obtained results reveal that the discovery volume influences and interferes in the recognition of the impairment expenses attributed to the E&P segment.

The idea is that oil reserves are the assets the make oil and gas exploration and production companies feasible. Thus, among others, the values of these variables serve as parameters to assess the company's ability to locate economically feasible oil reserves.

At bottom, the identified variables influence and should be considered when calculating the impairment of an E&P asset. Therefore, companies that maintain a constant discovery rate tend to recognize less impairment in that segment, as the increase in that variable means lower impairment values of E&P assets.

6. CONCLUSIONS

This study aimed to identify how the variables, considered as adverse situations that cause impairment, are related to losses in E&P assets' recovery value. In general, the impact of oil prices and changes in proven reserve volumes affect impairment losses attributed to E&P assets in crude-oil companies.

The inverse relation between impairment expense attributed to the E&P segment and discovery values was observed. Therefore, companies with constant discovery rates tend to recognize less impairment for the segment, as an increase in proven reserves means higher recoverability of E&P assets.

The practice of impairment tests implicitly entails one of the main characteristics of the crude-oil industry – the existing risk of finding, or not, economically feasible mineral reserves.

Based on this information, oil and gas industry assets, especially in the E&P segment, present specific characteristics, not only deriving from the expense capitalization methods, but also from the identification of the future benefits these assets produce.

Two facts should be mentioned as possible study limitations: 1) the short time period of six years for each company included in the analysis (2003 to 2008), so that statistical significance was not considered in the calculation of the correlation coefficients; and 2) the fact that the selected time period (time window) is characterized by a constant rise in oil prices, which may have influenced the conclusion that the "price variable" did not behave as proposed.

Finally, different questions were raised throughout this research, guaranteeing a vast area for further research and studies about impairment. In the universe of possibilities, research can be recommended to identify how the quality of discoveries influences the ability to enhance the cash flow of E&P assets and, consequently, to decrease impairment losses.

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