

Comparability of Divergent Financial Statements in the Petroleum Exploration Industry*

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1. INTRODUCTION

Accounting practices used in the petroleum industry are marked by substantial intra- and inter-industry differences. Such diversity makes the task of comparing financial statements and performance of petroleum exploration firms especially difficult. From the point of view of financial analysts and many other users of financial information, it would be desirable to have all firms use a uniform set of accounting procedures. Today, the petroleum industry and the accounting profession are sharply divided on the propriety of various accounting procedures and uniformity seems to be a distant goal at best.¹

Until such time as these differences are resolved, the external users of financial statements must make the best use they can of the accounting information published by different firms using different accounting methods. In this paper, I present a method of adjusting divergent financial statements to a comparable basis.² The discussion is limited to the variations in the

* The National Science Foundation provided a part of the financial support for this research.

capital/expense decision for prediscovery costs in the petroleum exploration industry.

Prediscovery costs include the costs of geological and geophysical exploration, property acquisition and carrying costs, and exploratory drilling costs. Some accountants recommend capitalizing all prediscovery costs. Others would relate parts of such costs to successful and unsuccessful segments of the exploration activity.

The practice of capitalizing only those prediscovery costs which are directly identifiable with the discovery of a commercial reserve and treating all other costs as operating expense is referred to as successful efforts costing (SEC). On the other hand, the practice of capitalizing all prediscovery costs irrespective of the results of exploration is called full costing (FC). Several variations of each accounting method are used in practice. These variations are ignored in the analysis presented here in order to highlight the differences (or lack of them) between the SEC and FC methods in their "pure" form and define procedures for converting SEC financial statements to FC basis and vice versa.

Since the sum of earnings over the life time of a firm is invariant to alternative accounting procedures used for reporting purposes (as against those used for tax purposes), the basic effect of accounting policies on earnings is to determine their distribution over the life cycle. Patterns of earnings over the life cycle therefore provide a natural framework for a comparative study of alternative accounting practices. This framework is used throughout the present study.

The life cycle of a firm may be divided into several stages such as birth, growth, maturity, decline and the end. Different accounting practices result in different distribution of earnings over each stage of the life cycle. If the earnings of a firm in one stage of its life cycle are higher under accounting practice *A* than under accounting practice *B*, there is always another stage of life cycle when practice *B* is associated with the higher earnings. Ignoring the effect of an accounting practice over the entire life cycle of a firm may therefore lead to invalid conclusions about the consequences of an accounting practice. Once the patterns of earnings and other accounting variables of interest under alternative accounting practices over the life cycle of a firm have been determined, it is easy to examine the effects of accounting policies in any given stage of the firm.

We shall define a simple life cycle comprising three stages of a hypothetical firm engaged in exploration, development and exploitation of petroleum

reserves. In the first stage, when the firm is characterized as "new," it starts exploring for oil and maintains a constant level of exploration activity. If the firm takes L years on average to deplete an oil deposit it will reach a state of equilibrium or maturity in the $(L+1)$ st year of its operation. The firm will remain in the equilibrium state as long as it continues its exploration activity at the same level. The third stage of the simplified life cycle of our hypothetical firm starts in the year it stops all exploratory activity. During this "shrinking" stage, the firm extracts all oil from its accumulated deposits and is dissolved after L years when it is left with no further reserves.³ These three stages of the life cycle of a firm are marked along the horizontal axis of Figure 1.

The new and shrinking stages of the life-cycle are transient states in the sense that they cannot last forever. The mature state, on the other hand, is a permanent state which can last for an indefinitely long period. The value of various accounting variables for a mature firm need not remain constant over time. The equilibrium condition implies that the probability distribution of each accounting variable remains unchanged over time. A firm in equilibrium is a theoretical concept and few firms may actually fit the exact definition. Like other theoretical concepts in economics, how-

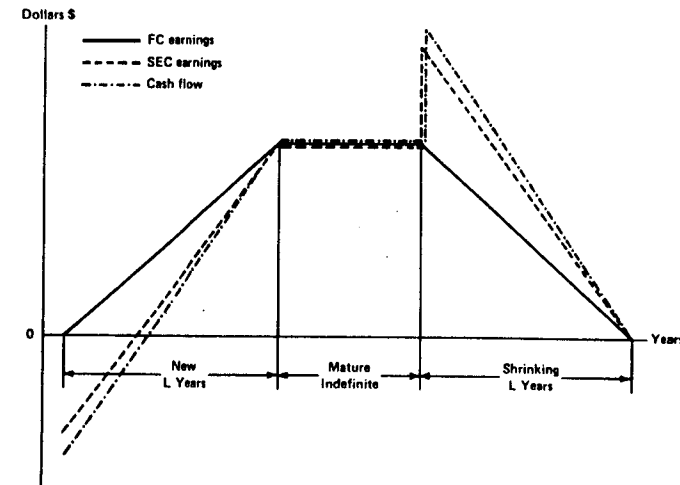


FIGURE 1. Averages of Cash Flow and FC and SEC Earnings over the Life Cycle of a Firm (not drawn to scale).

ever, it is a useful analytical device to identify the permanent and transient elements of the effect of an accounting practice on the financial statements of a firm.

Before proceeding further, we shall make a more detailed specification of our hypothetical firm in petroleum exploration, development, and extraction. The firm drills N exploratory holes each year during the new and mature stages of its life cycle and does not conduct any exploration during the shrinking stage. The prediscovery cost of each well is c dollars. On average, only one out of M exploratory wells is expected to result in finding a commercial deposit of hydrocarbons. The average revenue (net of the costs of development, extraction and transportation, etc.) from each commercial deposit is expected to be X dollars. The firm exploits a commercial deposit at a uniform rate over L years following the discovery to yield a net revenue of X/L dollars per year. The major uncertainty about the future of the firm is the number of commercial deposits discovered by its exploratory operations. On average, the firm will find N/M deposits each year but the actual number found can vary from zero up. The firm amortizes the capitalized prediscovery costs at a uniform rate over the L years immediately following the year in which the costs are incurred. In the remainder of this paper, we shall examine the behavior of various accounting variables and the problem of comparability of financial statements for such firms in various stages of their life cycle.

2. PATTERN OF EARNINGS UNDER SEC AND FC

The pattern of average earnings of the firm over its lifetime under each of the two accounting procedures is shown in Figure 1—FC income in solid line and SEC income in broken line.⁴

In the first year of its exploratory operations, the firm has no reserves, no revenues, and under FC, no expenses since all exploration costs are capitalized. Thus, under FC the income is zero in the first year. As the firm discovers, develops, and exploits reserves, its average income starts increasing because the net revenue from extraction increases faster than the amortization charge on the capitalized exploration costs. By the time the

firm reaches its $(L + 1)$ st year, the level of revenue stabilizes as the rate of new discoveries becomes equal to the rate of depletion. The amortization charge under FC also stabilizes at the level of the annual exploration costs. The average earnings of the firm remain level from this time on. The first segment of the solid line in Figure 1 shows this increasing average income of a new firm.

Earnings of a new firm under SEC are negative in the first year since the unsuccessful exploration costs are expensed and there are no offsetting revenues. In the subsequent years, the average earnings of the firm increase at a constant rate from this initial level as the deposits found by the firm are developed and hydrocarbons are extracted. It is several years before the firm breaks even.⁵ In the $(L + 1)$ st year of its operation, the firm reaches the equilibrium state and a stable level of average earnings.

Throughout the first L years of operation of a new firm, its income under SEC is lower than under FC method of accounting. Since the realized revenues under the two procedures are the same, the difference is accounted for by the higher expenses recognized under SEC during these years. A financial analyst may be interested in estimating the FC earnings of a new firm which reports on SEC basis. If one had access to detailed financial data of the firm, both FC and SEC earnings could be directly computed. Since such data are often unavailable, we present a quantitative conversion rule which requires only minimal information and results in reasonable approximations. The average earnings in the t th year of operation of a new firm under FC and SEC are given by expressions $N(X/M - c)(t - 1)/L$ and $N[(X - c)(t - 1)/L + c]/M - Nc$, respectively.⁶ The difference between FC and SEC earnings in the t th year of operation is

$$[N(X - c)(L + 1 - t)/L] \cdot M.$$

As can be seen from Figure 1, this difference is at a maximum of $N(X - c)/M$ in the first year of operation ($t = 1$) and decreases each year by $[N(X - c)/L] \cdot M$ until it becomes zero in the $(L + 1)$ st year. These expressions provide a basis for converting FC earnings to SEC earnings and vice versa for a new firm.⁷ Admittedly, these conversions provide only estimates and not the actual earnings that would have been reported under the alternative accounting procedure. If more detailed financial information is available to an analyst, it can be used to improve the accuracy of the estimates provided by the conversion rule given above for new firms.

While the level of FC earnings is higher than the level of SEC earnings for a new firm, the rate of growth of FC earnings is lower than the rate for the SEC earnings by $Nc(M - 1)/ML$. The FC earnings increase at the rate of $N(X/M - c)L$ per year while the corresponding rate for SEC earnings is $N(X - c)/ML$.

Since the difference between average FC and SEC income is maximum at the beginning and decreases, both in absolute and relative terms, as the firm approaches maturity, the conversion rule is most useful during the early years of life of the firm. The importance of FC/SEC distinction declines with time and disappears when the firm reaches the state of equilibrium. The average earnings of mature firms that have been in the petroleum exploration business for a long time and whose growth in operations and holdings of reserves has levelled off, are not at all affected by the accounting method they select for reporting their earnings. If a firm has been using successful efforts costing since its inception, its earnings would be no higher or lower than those of another similar firm which has used the full costing method all the time, once both these firms reach maturity, and there is no need to make conversions from SEC income to FC income or vice versa.⁸ Unfortunately, this implication of the alternative treatment of the capital/expense decision for prediscovery has received insufficient attention in the accounting literature. It is much more common to state that the FC method results in higher reported earnings than the SEC method. While it is true of the earnings of a new firm, it is not true in general unless the only firms we are interested in are new or growing firms. The current state of the petroleum exploration industry and the long-term outlook for the future does not justify such an assumption. Petroleum exploration activity in the U.S. levelled off several years ago and is not expected to grow at a substantial rate in the future. There is reason to believe that the current state of the exploration industry and of many firms is better described as stable than as new or growing. Implications of SEC and FC accounting for mature and shrinking firms therefore cannot be ignored.

Invariance of the earnings of a mature firm to its method of accounting for prediscovery costs arises out of the basic nature of conservative accounting practices. Since the lifetime earnings of a firm are invariant to the accounting method used for reporting purposes, accounting practices which are conservative with respect to the current earnings are necessarily liberal with respect to the future earnings. As long as the firm keeps growing, the

negative effect of conservatism on current earnings exceeds the countereffect of past conservative practices and the use of successful efforts method can be validly labeled as being conservative. When the firm reaches a state of equilibrium and its holdings of reserves, rate of production, etc. become stable, the countereffect of conservative practices of the past becomes exactly equal to the effect of current practice on earnings. Thus conservative/liberal labeling of SEC and FC accounting alternatives is meaningless as far as the earnings of such mature firms are concerned. It is important to point out here that two conditions must be fulfilled for a firm to be defined as mature—first, it should have been operating for long enough to have completed at least one cycle of petroleum reserves from discovery to depletion. The second condition is that for the period of the most recent cycle, the firm should have been exploring at a constant rate.

From a financial analyst's point of view, the earnings of mature FC and SEC firms are of equal "quality" and there is no need to discount the earnings of the FC firms. While FC earnings contain a smaller element of expensed exploration costs of the current period, they also include a larger amortization charge, and the sum of the two elements is equal to the sum of current expense and amortization charge under SEC on average. The result is that the earnings of mature FC and SEC firms are directly comparable and need not be adjusted by the analyst.

The last phase of the life cycle of a firm, when it is referred to as a shrinking firm, starts when the firm begins to scale down its exploratory effect or stops it altogether. We shall examine the behavior of the earnings of a mature firm which stops its exploration activity all at once. The FC and SEC earnings of the firm in the shrinking phase are plotted in the last part of Figure 1. Throughout this phase, the SEC earnings exceed the FC earnings. While the FC earnings decline from the equilibrium level to zero at a uniform rate over L years, the SEC earnings experience a sudden and substantial increase of $Nc(M - 1)/M$ above the equilibrium level in the first year of the shrinking phase and decline uniformly from this level to zero over the following L years. Thus the conservatism of SEC earnings during the growth phase of a firm's life cycle reappears as an overstatement of earnings during the shrinking phase. In this phase, conversion of FC earnings to SEC earnings can be made by adding an amount $N(X - c) \cdot (L + 1 - t)/LM$ in the t th year of the shrinking phase of the firm. The difference becomes zero in the $(L + 1)$ st year of the shrinking phase when the

firm exhausts all its reserves. This stage could be interpreted either as liquidation of the firm or as closing of the petroleum subsidiary of a larger corporation.

I have deliberately limited the above discussion of the difference between FC and SEC earnings to three pure cases of new, equilibrium and shrinking firms who have stopped exploration abruptly. The relationships between the SEC and FC earnings under other phases of their life cycle such as growth—when they are increasing the scale of exploratory activity—and negative growth—when they are gradually reducing the scale of exploration—can be similarly determined but are not pursued here.⁹

3. EARNINGS AND CASH FLOW

Since our discussion is limited to accounting alternatives for reporting purposes only, the cash flow of the firm is unaffected by the choice of the accounting procedure. It is, however, interesting to examine the relationship between the cash flow and the two measures of income under consideration. The behavior of the average cash flow of a firm over three phases of the life cycle of a firm is plotted in Figure 1 in chain dotted line. When the firm is new, the cash flow is always less than both FC and SEC earnings though the difference decreases to zero as the firm approaches maturity. During the equilibrium phase, the average value of cash flow is the same as the average value of both FC and SEC earnings. In fact, the cash flow during this phase is identical to the FC earnings because FC amortization charge is equal to the current costs of exploration. In the last phase of the life cycle, cash flow exceeds both FC and SEC income on average and the difference decreases to zero as the firm approaches liquidation.

Since published financial statements provide information about the cash flow as well as one of the two earnings figures, both reported numbers can be used to improve the accuracy estimates of the unreported earnings number. If a firm reports SEC income, we can obtain two estimates of FC income—one from SEC income and the other from cash flow and combine the two to arrive at a better estimate. A similar procedure could be used to estimate SEC income from FC financial statements. Table 1 summarizes this estimation procedure.

TABLE 1. Conversion between the Average Values of Accounting Variables under FC and SEC.

From	To	New Firm Operation, Quantity $t \leq L$	Mature Firm Operation, Quantity	Shrinking Firm Operation, Quantity $t \leq L$
1. FC Earnings	SEC Earnings	Subtract $[N(X - c)(L + 1 - t)/L] \cdot M$	No change	Add $[N(X - c)(L + 1 - t)/L] \cdot M$
2. FC Earnings	Cash Flow	Subtract $Nc(L + 1 - t)/L$	No change	Add $Nc(L + 1 - t)/L$
3. SEC Earnings	FC Earnings	Add $[N(X - c)(L + 1 - t)/L] \cdot M$	No change	Subtract $[N(X - c)(L + 1 - t)/L] \cdot M$
4. SEC Earnings	Cash Flow	Subtract $[Nc(L + 1 - t)/L] \cdot M$	No change	Add $[Nc(L + 1 - t)/L] \cdot M$
5. Cash Flow	FC Earnings	Add $Nc(L + 1 - t)/L$	No change	Subtract $Nc(L + 1 - t)/L$
6. Cash Flow	SEC Earnings	Add $[Nc(L + 1 - t)/L] \cdot M$	No change	Subtract $[Nc(L + 1 - t)/L] \cdot M$
7. FC Capitalized Exploration Costs	SEC Capitalized Exploration Costs	Divide by M	Divide by M	Divide by M
8. SEC Capitalized Exploration Costs	FC Capitalized Exploration Costs	Multiply by M	Multiply by M	Multiply by M
9. FC Owners Equity	SEC Owners Equity	Subtract $(1 - 1/M)$ of Capitalized Exploration Costs Under FC	Subtract $(1 - 1/M)$ of Capitalized Explora- tion Costs Under FC	Subtract $(1 - 1/M)$ of Capitalized Exploration Costs Under FC
10. SEC Owners Equity	FC Owners Equity	Add $(M - 1)$ Capitalized Exploration Costs Under SEC	Add $(M - 1)$ Capiti- alized Exploration Costs Under SEC	Add $(M - 1)$ Capitalized Exploration Costs Under SEC
11. FC Earnings Variance	SEC Earnings Variance	Add $Nc(M - 1)$ $[cL + (t - 1)(2X - c)]/EM^2$	Add $Nc(M - 1)$ $[2X - c(L + 1)]/LM^2$	Variance is zero for both SEC and FC earnings

4. VARIABILITY OF THE EARNINGS STREAM

For firms in equilibrium, the year to year variability of earnings under FC and SEC methods depends on how fast the discovered reserves are exploited. If exploitation is carried out at a relatively fast rate, variability of FC earnings is higher, otherwise SEC method results in higher variability of earnings. If an analyst uses the historic variability of income as a measure of riskiness of the firm, he can use the following expressions to bring the variance (which is a measure of variability) to the earning stream of FC and SEC firms in equilibrium to a comparable basis:

Variance of SEC earnings =

$$\text{Variance of FC earnings} + cN(M - 1)[c(L + 1) - 2X]/LM^2.$$

In other words, the variance of SEC earnings is higher when L , the time span of exploitation is greater than $[(2X/c) - 1]$. The relationship between the variance of earning streams for new firms can be determined in a similar manner. Since there is no exploration and therefore no uncertainty in the shrinking phase, the variance of earnings under both SEC and FC is zero.

5. COMPARABILITY OF THE BALANCE SHEET

Capitalized value of prediscovery costs on the balance sheet is determined by the capital/expenditure decision for prediscovery costs. The behavior of capitalized costs over the life cycle of a firm under each accounting procedure is shown in Figure 2. New firms have zero capitalized costs at the beginning. The costs accumulate on the balance sheet at a decreasing rate until the firm reaches maturity. The capitalized value of prediscovery costs on an FC balance sheet of a mature firm remains constant and is equal to the exploration costs incurred in $(L + 1)/2$ years if the capitalized costs are amortized over L years by the straight line method. Once the firm enters the shrinking stage, the capitalized costs on the balance sheet decrease at

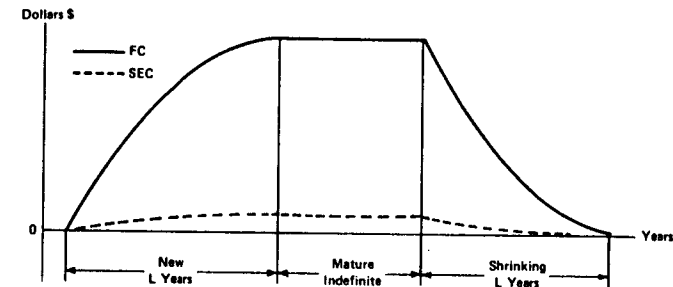


FIGURE 2. Behavior of Average Capitalized Prediscovery Costs under FC and SEC (not drawn to scale).

a decreasing rate. Capitalized costs under FC are not affected by the results of exploration and therefore can be determined from the size of the exploration program.

Unlike the capitalized exploration costs under FC, the equilibrium capitalized costs under SEC cannot be completely determined by the size of the exploration program alone because it depends, among other things, on the results of exploration. The actual value of capitalized costs will fluctuate around an average value from year to year depending on the results of exploration. The variability of these assets depends on the size of exploratory operations of the firm and the rate at which the reserves are exploited.

If more detailed financial data are not available, a financial analyst may adjust a balance sheet of an FC firm to SEC basis by reducing the capitalized exploration costs on the balance sheet by a factor M where one out of every M exploratory holes results in a commercial discovery on average. If, for example, an FC firm has \$1 million of capitalized prediscovery costs and one out of every thirty wells results in discovery of a commercial deposit, the firm would have about \$1/30 million of capitalized rediscovery costs under the SEC method. This relationship holds in all stages of the life cycle of a firm.

The owner's equity on the balance sheet can be similarly adjusted by an equal amount.

The debt-equity ratios of mature firms can also be adjusted to a comparable basis. Since the outstanding amount of debt is unaffected by the

accounting choice between SEC and FC methods, the adjusted debt equity ratio can be determined from adjusted owners' equity figures as discussed above. It is easy to show that the debt equity ratios of equilibrium firms under FC method are lower than under the SEC method.

6. PERFORMANCE RATIOS

Probably the most commonly used performance ratio in financial analysis is the rate of return on assets. The choice of accounting procedure between SEC and FC affect both the numerator and the denominator of this ratio and the problem of making this ratio comparable is particularly interesting. Fortunately, for a firm in equilibrium, the average though not the actual value of income is the same under both methods of accounting. The denominator is the sum of two elements—the capitalized exploration costs and all other assets. As we have already discussed, the average value of capitalized exploration costs under SEC is $(1/M)$ times the capitalized exploration costs under the FC method. The second part of denominator—all other assets—remains unaffected by the accounting method. The rate of return on assets for a firm can be recomputed under the alternative accounting procedure identifying the value of M , and the capitalized exploration costs element of assets in the balance sheet. The return on assets is higher for the SEC firms in equilibrium than for similar FC firms.

The use of SEC does not necessarily result in a higher rate of return on assets for new and shrinking firms. The behavior of return on assets under SEC and FC over the life cycle of a firm is shown in Figure 3. In the first year of its operations, the total assets of a new firm are invariant to the method of accounting for prediscovery costs because capitalized costs are zero. Since the income is higher for FC firms, the FC rate of return on assets is also higher in the early years. With each succeeding year, the difference between average income under SEC and FC decreases until it is zero in year $(L + 1)$. In addition, the FC firm accumulates capitalized assets much faster than the SEC firm does. The result is that the rate of return advantage enjoyed by FC firm in the beginning is progressively eroded and some time

before equilibrium is reached, the SEC firm gains the rate of return advantage and maintains it through the state of equilibrium. Once the firm starts the shrinking phase of its life cycle, the return on assets under SEC experiences a sudden increase because the SEC earnings increase. The rate of return on assets under SEC remains higher than the rate under FC throughout the shrinking phase of the firm's life cycle as shown in Figure 3.

7. CONCLUDING REMARKS

Successful efforts costing for prediscovery costs is frequently labeled as a more conservative accounting practice than the full cost accounting. If conservatism is defined as the preference for an understatement over an overstatement of current earnings, SEC can be called conservative for only those firms which are new or growing in size. For other firms, characterization of the SEC as a conservative practice is not appropriate.

The above procedure provides estimates of income in the absence of

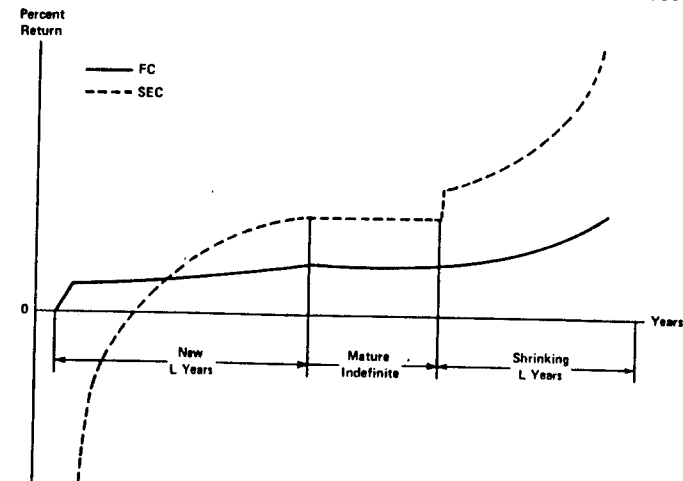


FIGURE 3. Behavior of Return on Assets under FC and SEC over Life Cycle of a firm (not drawn to scale).

detailed financial data for the firm from which *actual* income under alternative accounting procedure could be computed. The above procedure replaces the need for detailed data by estimates of important parameters such as X , L , O , c and N which are more easily available. Whenever detailed data for a firm is available to enable the financial analyst to compute earnings under alternative accounting procedure, it will clearly yield superior results. The use of such data will almost always require much greater effort from the analyst than the above mentioned procedures do. Whether or not the additional effort and cost is worth the added accuracy is a matter of individual judgment.

NOTES

1. Porter [5] is a standard reference for the accounting practices of the petroleum industry. For an analysis of various accounting issues in the petroleum industry, see Coutts [2] and Field [3]. ABP Public Hearings [1] is an excellent source of position papers on controversial aspects of petroleum accounting. For financial analysts' point of view, see Norr [4] as well as APB Public Hearings [1].
2. The relationship between a pair of financial statements is divergent if they have been prepared by using different accounting procedures.
3. The word "firm" is used here and throughout this paper to refer to a business entity engaged in exploration, development and extraction of petroleum. The entity may be an independent firm or be a division of a larger firm with diversified interests.
4. For detailed analytical results on which the following discussion is based, see Sunder [6, 7].
5. The breakeven level is reached in year $[(M - 1)L/(X - c)] + 1$ and is given by the point in Figure 1 where broken line crosses the horizontal axis.
6. Notation:

N = number of exploratory wells drilled each year;

M = average number of exploratory wells drilled for each successful one;

c = exploration cost per well which are expensed under SEC but capitalized under FC;

X = average total revenue (net of development, production and transportation costs) per successful exploration well;

L = average production life of a successful well in years;

t = year of operation.

7. See Table 1 for a summary of all conversion rules.
8. Note that we are discussing the comparisons between average income of a stable firm under SEC and FC. To the extent that the level and results of exploration efforts of a firm fluctuate from year to year, the specific incomes under the two methods will deviate from the averages. As we have already mentioned, better adjustments can be made when more detailed financial data are available. In the absence of such data, averages provide the best means of comparison. We shall return to this issue in the concluding section of the paper.
9. See Sunder [6, 7] for further details.

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