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The Choice of Strategic Core - Impact of Financial Volum

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Abstract

Recent trends among major oil companies and independents have been consolidation through mergers and acquisitions and focus on key strategic core areas. The expressed goals have been to achieve synergy, reduce costs, and concentrate on areas with maximum expected value creation. This paper provides a model that endogenously determines the optimal numbers of projects to implement in an optimal number of areas. The decision of whether to invest in a project cannot be seen in isolation but must be linked with portfolio optimization and the strategic core of the firm.

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1 Introduction

The question of whether the strategic core is a constraint on the portfolio optimization problem, whether the strategic core is a result of the optimization problem, or whether the strategic core is a result of an iterative process between strategic core discussions and portfolio optimization is interesting. Our opinion, from observations, is that the iterative process is the most common.

Existing taxation theory makes simplifying assumptions with respect to the firm's investment behavior where it is assumed that companies use elementary investment analysis where capital is perceived to be the primary scarce factor. Consequently, some authorities believe the internal rate of return (IRR) to be the relevant decision-making criterion where the neutrality criterion states that if a project has a positive (negative) internal rate of return before tax it should have a positive (negative) return after tax. Note that with IRR-evaluation, the absolute size of the discounted after-tax cash flow - often referred to as financial volume or materiality – is not considered as integral for the decision whether to invest or not. If a project has an IRR higher than the required rate of return, the project will be implemented. This seems to be at deviance with investment patterns in the oil industry, where there seems to be a clear preference for projects with a high financial volume. A small project can be unattractive even if it gives a high expected IRR.

Materiality requirements - requirements for minimum level of after-tax net present value - can be justified on the basis of different academic disciplines. Corporate strategy, accounting, corporate finance, management and investment analysis can all provide arguments for the need of a certain critical mass of financial return to justify investment decisions. The petroleum companies' increasing materiality requirement is closely connected with their focusing strategies, i.e., a narrower definition of their strategic core. In recent years the oil industry has experienced large portfolio adjustments. They concentrate scarce resources on fewer activities (fewer parts of the value chain - outsourcing - and fewer geographical areas), focusing on those areas where they have comparative advantages. In return, they demand larger contributions after tax, measured in absolute value, from each of these selected activities. A stronger focus on the materiality of projects is partly also a result of a number of mergers and acquisitions in the industry, with larger companies going for high materiality projects that can justify the relatively high level of indirect costs in large corporations. Thus, a positive net present value is, in connection with such allocation strategies, only an entrance ticket to transnational companies' ranking of projects on a global basis. It is a necessary yet not sufficient condition for realisation.

The materiality requirements may also be looked upon from a finance and management theory setting. Recognition is increasing that corporations incur certain amount of costs that for different reasons are not included in the expected project cash flow. One way to make allowances for these extra costs generated by a project is to demand a certain minimum size for the present value of projects.[2] One may envisage far more sophisticated methods by which to rectify this problem, but simple, workable management systems are often the preferred solution by companies. Materiality requirements may also follow directly from traditional economic decision analysis if one recognises that the real decision problem is non-linear and non-divisible, with a number of scarce factors and fixed costs. In the portfolio investment model derived below, materiality and its importance in practical decisions is illustrated. We employ data from actual petroleum projects on the Norwegian Continental Shelf.

The insight into materiality is general and may appear in a more conventional model. Consequently, the materiality result does not depend on our specific assumptions regarding price development etc. We do not claim the example to be of universal validity, though. There may be situations in which constraints on scarce factors do not bind and in which monitoring costs are low. However, in view of the petroleum companies' focusing strategy, there is reason to believe that materiality considerations play a central role in these companies' allocation and localisation decisions.

Materiality is particularly important in the petroleum industry, an industry dominated by a few profitable players. Through their international mobility and access to private information[3] these companies succeed in capturing part of the resource rent generated from scarce petroleum resources. Taxation never reaches 100 per cent, and the companies keep a mobility rent and an information rent; see Osmundsen, Hagen and Schjelderup (1998). This is also valid for industries that exploit non-mobile natural resources, since the input factors and the companies are mobile.[4] Large discoveries in new basins, opening of established producing countries for transnational petroleum companies, and a reduction in the number of players through mergers and acquisitions, have increased competition between different producing

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[2] See for instance Zimmerman (1979).

[3] See Osmundsen (1995, 1998).

[4] The companies do not need to move all of the operations physically. The transnational oil companies' international activity is to a considerable extent managed from the head office.

countries to attract the most competent companies. This will make the fiscal terms more important, particularly in countries where the remaining acreage must be expected to yield economically marginal fields, i.e. where the resource rent is falling over time. For analyses of international tax and fiscal competition, see Zodrow and Mieszkowski (1986), Gresik (2001), and Olsen and Osmundsen (2001).

1.1 Internal rate of return analysis

In conventional examples based on internal rate of return a number of simplifying and often unrealistic assumptions are made, e.g. that other scarce factors are fully reflected in prices, that projects are fully divisible, and that all relevant costs are included in the calculation. In reality, there are often a small number of larger projects, and many scarce factors and bottlenecks. One such relevant scarce factor is qualified experienced professionals. For example, only few individuals possess the necessary qualifications and experience to manage complex development projects in the North Sea. Furthermore, competent geologists and geophysicists are scarce. Usually, managerial capacity is also a scarce factor. The companies will, in consequence, scrutinize what values (present value after tax) the companies can retain, compared to the input of professional resources and managerial capacity which could, alternatively, have been invested in projects in countries where the companies are allowed to retain a larger portion of the value created. The various projects also have to bear all area-dependent fixed costs and make contributions to the payment of overhead costs at the corporate level.

Our analytical approach to this decision problem is to use portfolio analysis to arrive at the portfolio of projects with greatest combined present value for the company, with consideration to fixed costs and resource and capital constraints. For practical reasons, however, firms often use simpler decision-making tools. One important reason is that investment recommendations or decisions are not made at the corporate level, but at a divisional level where not all constraints and costs are known. A practical way of paying consideration to scarce factors and area-dependent costs is therefore for the head office to demand a minimum size for a project's net present value after tax. Even though portfolio models are not necessarily used explicitly to deduce the optimal investment portfolio, such considerations may - via materiality requirements - be underpinning the choice of what core geographical areas the companies wish to invest in and how large equity shares the companies wish to go for. Simple capital allocation models, like a fixed investment budget and requirements of a certain financial volume, may act as a proxy or as an implementation mechanism for more advanced portfolio models.

1.2 Scarce input factors

Why, then, are these inputs scarce? If managers or professionals create values beyond the costs generated by them, one would think the companies would hire more staff until the last employee just barely satisfies his or her marginal cost. One reason why this is not automatically possible is that scarcity often does not concern professionals or managers as a group, but those that are highly qualified. It is argued that companies typically have a limited number of professionals and managers that are crucial to success and others that are important in completing the task to be undertaken. Due to asymmetric information - the fact that the individual employee knows more about his or her own skills than potential employers - it may be difficult to provide new such staff as and when required. Most likely one has to overstaff in order to be reasonably sure to capture some of the best individuals. Given a relatively rigid labour market, this is an expensive strategy, which is why the companies prefer to keep their organisation slim. Due to fluctuating levels of activity and costs of restructuring, there is reluctance to build up capacity that will subsequently have to be down-scaled.

Not only present value per scarce factor is important when companies decide where to invest. Beside the obvious elements such as prospectivity, level of cost, tax burden and acreage availability, the costs associated with being present in a region or country may be substantial and therefore the minimum profitable activity must be of a certain volume. Furthermore, most companies learn that a simple structure with management focus on a few matters is important. Areas which as such are commercial, but which do not generate much value after tax (make small contributions to payment of overhead costs) can thus be rejected so as to allow management and professional employees to focus on those areas where values are generated for the company. Reference is often made to materiality considerations, and there is reason to take these seriously. Norwegian branches or subsidiaries of transnational companies are arguing that projects of a small scale in a corporate context (often represented by expected present value after tax being low) have difficulties in attracting attention - and thus investment funds - from the head office. This line of reasoning has gained a foothold also in the Norwegian companies, in parallel with their growing international activity. Note that even though the total project may be large, materiality can nonetheless be limited viewed from the perspective of a large international corporation if the company holds a low equity share in the project.

1.3 Factors determining the materiality of a project

Materiality can be analysed at two main levels: 1) project level (field), and 2) basin level (geological area). Both levels are argued to be relevant. E.g., as far as the project level on the Norwegian Continental Shelf is concerned, there is a development towards smaller fields. In an international context, though, these fields will still be considered large. New Norwegian fields are, on average, several times the size of fields on the UK Continental Shelf. Recently, there has been a marked shift to positive exploration results, also including large discoveries.

Gradual emergence of vacant capacity within processing and pipeline transportation in mature areas as established fields are phased out may make the development of satellite fields highly profitable. This presupposes the ability to keep down the costs of operation and maintenance of old production facilities. However, in some new potential discovery areas problems are faced pertaining to long distances from existing infrastructure. Tightened cost control in development projects is also important for the profitability of new field developments.

Other factors influencing materiality, both at the project and basin level, are the scope and prospect of exploration acreage, the tax system and the distribution of equity shares in the licenses. A high marginal tax causes lower portions of the total cash flow to be retained by the companies. A similar reduction in cash flow is caused when companies hold limited equity shares in the license. Other companies' equity shares and the Norwegian State share via the State’s Direct Financial Interest (SDFI) reduce the share of the net cash flow (and the investments) to each individual company. This reduces the size of the NPV to each company. The internal rate of return, however, remains unchanged provided the company is in a tax paying position. Hence taxation does not reduce the profitability of the investment, but is instrumental in scaling down the project for each individual company. This reduces the NPV after tax and thus the materiality of the project. Further commercialisation of the SDFI (sale of equity shares from the State to privately run companies) could, in consequence, help bring about a substantial improvement in materiality for the companies on the Norwegian Continental Shelf. A change in the licensing policies, involving larger equity shares for the privately run companies, has also improved the materiality conditions on the Norwegian shelf.

2 Formulation of the standard model

Consider an oil company operational with N_i projects in each of A geographically dispersed areas, i=1,…,A, $N_i \geq 1$, $A \geq 1$. Denote the gross income from project j in area i as $I_{ij}=PQ_{ij}$, where P is the oil price per barrel in US$ (assumed equivalent across all areas) and Q_{ij} is the oil production in million barrels from project j in area i. Assuming actual sale equal to production, the company's gross income across the A areas is

$$G = \sum_{i=1}^{A}\sum_{j=1}^{N_i} I_{ij} = \sum_{i=1}^{A}\sum_{j=1}^{N_i} PQ_{ij}. \tag{2.1}$$

The company incurs the following costs.

(a) CAPEX:

$K = \sum_{i=1}^{A}\sum_{j=1}^{N_i} K_{ij}$: Capital expenditure (CAPEX) for starting up all projects in all areas, where K_{ij} is capital expenditure for project j in area i.

(b) OPEX:

Operating expenditure (OPEX) is composed of wages, administration costs, and other costs.

$\omega_i = \omega_i\left(\sum_{j=1}^{N_i} K_{ij}\right)$: Wages paid for all personnel in area i as a function of investment costs, excluding wages for personnel at the head office. Personnel are employed at the area level and move within and between projects. Financial wages are assumed to increase in the scale of operations (represented by investments) since the firm typically is a large employer for the relevant categories of personnel i.e. $\partial\omega_i \big/ \partial\sum_{j=1}^{N_i} K_{ij} > 0$. To the extent there is economics of scale for projects related to normal wages, $\partial^2\omega_i \big/ \partial\left(\sum_{j=1}^{N_i} K_{ij}\right)^2 < 0$. This case, where the second order derivative is negative, is more realistic since it is likely that all personnel functions do not increase as the project size increases (investments increases).

β : Fixed administration costs such as electricity, rent, etc. to set the stage for being operational.

γ_{ij} : Other fixed costs related to project j in area i.

Opportunity cost of capital:
$k = k\left(\{N_i\}_A, A, \sum_{j=1}^{N_i} K_{ij}, \sum_{i=1}^{A}\sum_{j=1}^{N_i} K_{ij}\right)$, $k_i = k_i\left(\{N_i\}_A, \sum_{j=1}^{N_i} K_{ij}\right)$, k_{ij}, where $\{N_i\}_A$ is the set of all projects in all areas A: Opportunity cost $k \in (0,1)$ of capital for all projects and areas, for area *i*, and for project *j* in area *i*, respectively. Choosing projects with different systematic risk will change *r* for the company. In market theory of pricing, the capital asset pricing model (CAPM, Sharpe 1964, Lintner 1965), a rational investor is fully diversified. Consequently, it is argued that diversification should be left to private investors who may diversify more cheaply than the company. However, due to risk of bankruptcy and principal-agent issues where managers may prefer more stable income and less personal risk, investments in many areas, ceteris paribus, reduce country and portfolio specific risk. We define the opportunity cost factors $r, r_i, r_{ij} \in (0,1)$ of capital as $r = \sum_{t=0}^{T}\left(1/(1+k)\right)$, $r_i = \sum_{t=0}^{T}\left(1/(1+k_i)\right)$, $r_{ij} = \sum_{t=0}^{T}\left(1/(1+k_{ij})\right)$, where t is time and T is the final time period. A more balanced portfolio implies a higher opportunity cost factor of capital relative to risk, at a decreasing rate $\partial r/\partial N_i > 0$, $\partial r/\partial A > 0$, $\partial^2 r/\partial N_i^2 < 0$. From the same type of reasoning it follows that particularly high investments in any one area *i* leads to a lower opportunity cost factor of capital due to the higher risks stemming from an unbalanced portfolio, i.e. $\partial r/\partial \sum_{j=1}^{N_i} K_{ij} < 0$, $\partial^2 r/\partial\left(\sum_{j=1}^{N_i} K_{ij}\right)^2 < 0$. The opportunity cost factor of capital of the corporation is decreasing and concave in the overall investment level, i.e. $\partial r/\partial \sum_{i=1}^{A}\sum_{j=1}^{N_i} K_{ij} < 0$, $\partial^2 r/\partial\left(\sum_{i=1}^{A}\sum_{j=1}^{N_i} K_{ij}\right)^2 < 0$. This concavity has several explanations. One is financial. Funding may be more expensive at the margin, e.g., due to a lower credit rating in times of high overall investments. The concavity may also be a consequence of project execution. The offshore petroleum industry is characterized by few firms and large, indivisible investments. A high overall activity level may thus push suppliers - e.g. in the construction industry - to their capacity limits, implying higher procurement costs for the oil company.

Standard evaluations with calculations for project *j* in area *i* constitute a benchmark for our analysis with project based present value of residual income (PVRI) R_{ij}^{p}, given in (2.2), calculated as gross income I_{ij} minus cost $K_{ij} + W_{ij}$, adjusted with the opportunity cost factor of capital, i.e.

$$R_{ij}^{p} = r_{ij}\left[I_{ij} - \left(K_{ij} + W_{ij}\right)\right],\quad W_{ij} = \omega_{ij}^{p}(K_{ij}) + \beta_{ij} + \gamma_{ij},\quad \beta_{ij} = \beta K_{ij}\Big/\sum\nolimits_{i=1}^{A}\sum\nolimits_{j=1}^{N_i} K_{ij},$$
$$R^{p} = r\left(\{N_i\}_A, A, \sum_{j=1}^{N_i} K_{ij}, \sum_{i=1}^{A}\sum_{j=1}^{N_i} K_{ij}\right)\left[\sum_{i=1}^{A}\sum_{j=1}^{N_i} PQ_{ij} - \left(\sum_{i=1}^{A}\sum_{j=1}^{N_i} K_{ij} + \sum_{i=1}^{A}\sum_{j=1}^{N_i} W_{ij}\right)\right], \tag{2.2}$$

where $\omega_{ij}^{p}(K_{ij})$ are wages for project *j*. We interpret (2.2) to constitute a formulation of “received theory” or “contemporary wisdom” compatible with models involving internal rate of return (IRR) and net present value (NPV). Current tax theory suggests that project *j* is implemented in area *i* if $R_{ij}^{p} > 0$. The next section demonstrates that standard theory is not descriptive of the behavior of oil companies.

3 The refined model

We believe that the standard model is not complete in that it fails to recognize two types of company costs. These are excess opportunity costs for strategic personnel and monitoring and coordination costs for the head office.

(c) $\alpha = \alpha\left(\{N_i\}_A, A, \sum\nolimits_{j=1}^{N_i} K_{ij}, \sum\nolimits_{i=1}^{A}\sum\nolimits_{j=1}^{N_i} K_{ij}\right)$, $\alpha_i = \alpha_i\left(\{N_i\}_A, \sum\nolimits_{j=1}^{N_i} K_{ij}\right)$: Excess opportunity costs for strategic personnel for all projects and areas, and for area *i*, respectively. Higher opportunity costs for strategic personnel occurs at an increasing rate with more projects, more areas, and higher levels of investments, i.e. $\partial\alpha/\partial N_i > 0$, $\partial\alpha/\partial A > 0$, $\partial\alpha\Big/\partial\sum\nolimits_{j=1}^{N_i} K_{ij} > 0$, $\partial\alpha\Big/\partial\sum\nolimits_{i=1}^{A}\sum\nolimits_{j=1}^{N_i} K_{ij} > 0$, $\partial^2\alpha/\partial N_i^2 > 0$, $\partial^2\alpha/\partial A^2 > 0$, $\partial^2\alpha\Big/\partial\left(\sum\nolimits_{j=1}^{N_i} K_{ij}\right)^2 > 0$, $\partial^2\alpha\Big/\partial\left(\sum\nolimits_{i=1}^{A}\sum\nolimits_{j=1}^{N_i} K_{ij}\right)^2 > 0$.

(d) Monitoring and coordination costs for head office:

Overall monitoring costs for the firm are $M = M\left(\{N_i\}_A, A, \sum\nolimits_{j=1}^{N_i} K_{ij}, \sum\nolimits_{i=1}^{A}\sum\nolimits_{j=1}^{N_i} K_{ij}\right)$, convexily increasing in $\partial M/\partial N_i > 0$, $\partial M/\partial A > 0$, $\partial M\Big/\partial\sum\nolimits_{j=1}^{N_i} K_{ij} > 0$,

$\partial M \big/ \partial \sum_{i=1}^{A}\sum_{j=1}^{N_i} K_{ij} > 0$, $\partial^2 M / \partial N_i^2 > 0$, $\partial^2 M / \partial A^2 > 0$, $\partial^2 M \Big/ \partial \left(\sum_{j=1}^{N_i} K_{ij}\right)^2 > 0$, $\partial^2 M \Big/ \partial \left(\sum_{i=1}^{A}\sum_{j=1}^{N_i} K_{ij}\right)^2 > 0$. A higher number of projects, ceteris paribus, leads to an increase in monitoring costs. The same applies to an increase in the number of geographical areas where the firm has operations. A higher overall activity level - represented by aggregate investments - also implies higher monitoring challenges.

Applying (c) and (d), (2.2) generalizes to

$$\begin{aligned} R = r\left(\{N_i\}_A, A, \sum_{j=1}^{N_i} K_{ij}, \sum_{i=1}^{A}\sum_{j=1}^{N_i} K_{ij}\right)\Bigg\{\sum_{i=1}^{A}\sum_{j=1}^{N_i} PQ_{ij} - \Bigg[K\left(A, \sum_{j=1}^{N_i} K_{ij}, \sum_{i=1}^{A}\sum_{j=1}^{N_i} K_{ij}\right) + \sum_{i=1}^{A}\omega_i\left(\sum_{j=1}^{N_i} K_{ij}\right) \\ + \frac{\beta_{ij}}{K_{ij}}\sum_{i=1}^{A}\sum_{j=1}^{N_i} K_{ij} + \sum_{i=1}^{A}\sum_{j=1}^{N_i}\gamma_{ij} + \sum_{i=1}^{A}\alpha_i\left(\sum_{j=1}^{N_i} K_{ij}\right) + M\left(\{N_i\}_A, A, \sum_{j=1}^{N_i} K_{ij}, \sum_{i=1}^{A}\sum_{j=1}^{N_i} K_{ij}\right)\Bigg]\Bigg]\Bigg\}, \end{aligned} \tag{3.1}$$

which we present as a formal tool for how oil companies calculate PVRI.

4 Case presentations: Illustrated with empirics and simulations

To aid the reader with the abstractions involved in developing the refined model, consider the project data for five projects which within the oil industry typically take the form in Table 1, reproduced from Osmundsen, Emhjellen and Halleraker (2001).

	Project 1			Project 2			Project 3		
Yr	Oil production Mill.bbl.	Real inv. cost $mill.	Real oper. cost $mill.	Oil production Mill. bbl.	Real inv. cost $mill.	Real oper. cost $mill.	Oil production Mill. bbl.	Real inv. cost $mill.	Real oper. cost $mill.
Sum	80,1	350,4	348,7	156,3	772	604,2	162,9	881,9	817,7
1		7,3	0,3					4,3	
2		93,1	6,1		8,9	0,6		97,1	1,4
3	3,7	161,6	21,7		58,4	2,9		471,4	4,3
4	14,8	86,1	53,8		291,7	10,3	1,9	221,4	29,7
5	14,8	2,3	48,5	13,7	312	35	17,5	50	81,2
6	14,8		48,8	31,4	97,7	77,6	23,3	37,7	80,2
7	14,3		48,7	31,9	3,3	83,2	24,2		82,3
8	9,1		44,9	26,2		83,2	24		84,5
9	5,1		39,8	19,9		80,5	21,5		82,8
10	3,5		36,1	14,7		78,6	14,8		77,7
11				10,3		76,7	11,5		75,4
12				8,2		75,6	9,2		73,8
13							7,9		72,9
14							7,1		71,5

	Project 4			Project 5		
Yr	Oil production Mill. bbl.	Real inv. cost $mill.	Real oper. cost $mill.	Oil production Mill. bbl.	Real inv. cost $mill.	Real oper. cost $mill.
Sum	314,5	982,4	1742,7	119	508,6	596,6
1						
2		184,8			120,6	6,1
3		182,6	10,6		163,4	5,4
4		236,1	17,1		181	22,5
5	9,4	94,5	71,9	18,2	43,6	77,5
6	15,1	115,8	94,3	18,2		78,4
7	20,8	78,1	113,8	18,2		76,2
8	23,3		121,1	18,2		77,1
9	23,3	51,7	122,5	18,1		76,5
10	23,3	38,8	122,5	12,3		59,7
11	23,3		122,5	7,3		45,2
12	23,3		122,5	4,9		37,9
13	23,3		122,5	3,6		34,1
14	23,3		122,5			
15	23,3		122,5			
16	23,3		122,5			
17	23,3		122,5			
18	23,3		122,5			
19	12,9		88,9			

Table 1. Project data. Oil production in million barrels per year is shown for each project under column 1, investment costs in million USD (fixed) under column 2 and operating costs in million USD (fixed) under column 3.

In Table 1 the years are listed vertically from 1 and upwards to 14 or 19. The three columns to the right of the year column, for each project, are the actual project data. In the middle column are the real investment costs, in section 2 labelled capital expenditure K_{ij} in million US$ for project *j* in area *i*. These costs are incurred in year 1 and subsequent years for projects 1 and 3, and in year 2 and subsequent years for projects 2, 4, 5. In the right column, for each project, are listed the real operating costs, labelled G_{ij} in million USD for project *j* in area *i*.

These costs are incurred the first time in the same year as the real investment costs, or the subsequent year. They usually run for a larger number of years and typically do not vary substantially from year to year when oil production is relatively constant. The left column, for each project, gives the oil production labelled Q_{ij} in million barrels for project j in area i. Oil production usually starts up a few years later than the first year of incurring real investment costs, and thereafter bears a certain correspondence to the operating costs.

In evaluating a project, an oil company usually considers the total costs and returns over the entire life span of the oil project, in Table 1 ranging from 10 to 18 years. We use the present value of the pre tax cashflows in Table 1 (assuming a real oil price of 15USD/bbl and a real rate of 8% in discounting) to calculate Table 2, assuming one area labeled area 1.

$PQ_{11}=759.7$ $K_{11}=297.7$ $W_{11}=215.3$
$PQ_{12}=1294.8$ $K_{12}=544.2$ $W_{12}=316.2$
$PQ_{13}=1298.9$ $K_{13}=682.0$ $W_{13}=416.1$
$PQ_{14}=1921.4$ $K_{14}=703.6$ $W_{14}=725.9$
$PQ_{15}=981.9$ $K_{15}=395.8$ $W_{15}=327.2$

Table 2 Examples of data for $N_1=5$ projects in area A=1.

The present value of residual income (PVRI) is thus $PQ_{ij}-K_{ij}-W_{ij}$. Using one area A=1, and five projects $N_i=N_1=5$. We calculate the results with our first case, the case where we use the standard model equation (2.2). Table 3 lists the 31 different project combinations in column 1 from the left, and the PVRI $R^p(r=1)$ for these project combinations in column 2 assuming r=1. The results in columns 3 to 6 are the result of subsequent cases and will be explained later.

	$R^p(r=1)$	$R^p(r)$	$R(A=1)$	$R(A=2)$	$R(A=3)$
1	246.7	246.7	246.7	499.6	754.515
2	434.4	434.4	434.4	879.577	1328.15
3	200.8	200.8	200.8	403.569	604.657
4	491.9	491.9	491.9	995.392	1502.07
5	258.9	258.9	258.9	523.723	790.031
12	681.1	681.304	677.093	1371.43	2071.51
13	447.5	447.634	442.734	893.737	1345.25
14	738.6	738.821	733.813	1485.69	2243.12
15	505.6	505.751	502.283	1016.87	1535.2
23	635.2	635.39	629.257	1271.43	1915.58
24	926.3	926.577	920.336	1863.39	2813.45
25	693.3	693.507	688.806	1394.57	2105.54
34	692.7	692.907	685.977	1385.69	2087.2
35	459.7	459.837	454.447	916.876	1379.28
45	750.8	751.025	745.526	1508.83	2277.15
123	881.9	882.426	867.178	1753.82	2644.93
124	1173.	1173.7	1158.24	2345.9	3543.24
125	940.	940.561	928.176	1879.94	2839.47
134	939.4	939.96	923.117	1866.53	2814.23
135	706.4	706.821	693.058	1400.57	2110.45
145	997.5	998.095	984.116	1992.65	3008.77
234	1127.1	1127.77	1108.46	2241.93	3381.25
235	894.1	894.633	878.404	1775.97	2677.48
245	1185.2	1185.91	1169.46	2368.06	3575.79
345	951.6	952.168	934.343	1888.68	2846.77
1234	1373.8	1375.03	1341.58	2714.95	4096.94
1235	1140.8	1141.82	1113.	2251.86	3397.33
1245	1431.9	1433.18	1404.03	2844.06	4296.07
1345	1198.3	1199.37	1168.15	2363.01	3564.31
2345	1386.	1387.24	1352.32	2736.12	4128.
12345	1632.7	1634.64	1582.11	3202.61	4834.12

Table 3 PVRI $R^p(r=1)$, $R^p(r)$, $R(A)$ for A=1,2,3 for 31 project combinations.

Column 2 specifies that project combination “12345”, i.e. all the five projects, is to be implemented according to current theory since that combination gives the highest PVRI R^p=1632.7.

The standard model assumes an opportunity cost factor r of capital where, in accordance with section 2, diversification increases r marginally as the number N_i of projects and number A of areas increase. A plausible choice of r used in the remainder of the article is

$$r = r\left(\{N_i\}_A, A\right) = \left(1.05 - 0.05e^{-0.006\left(\sum_{i=1}^{A} N_i - 1\right)}\right)\left(\frac{105}{100} - \frac{5}{100}e^{-0.4(A-1)}\right), \tag{4.1}$$

where any other r can be used without changing the logic of the argument in this article. When A=1, r increases from r=1 to r=1.05 as N_i increases from 1, and increases further to r=1.1 when A increases from 1. This increase in r then reflects the increase in present value following from the diversification argument related to opportunity cost of capital on page 6. Substituting r=1 with (4.1), column 3 in Table 3 lists the PVRI, where the highest is $R^P(r) = 1634.64$.

We believe that the choice of combination "12345", i.e. all five projects, is neither descriptive nor optimal for the oil industry. More specifically, we believe (2.2) to be inadequate as a foundational theory for investment patterns in the oil industry since it does not account for financial volume or materiality. Materiality is vital to actual project selection, due to excess opportunity costs α_i and monitoring costs *M*. Accounting for excess opportunity costs α_i and monitoring costs *M* as in section 3, a plausible choice of the last part of (3.1) is

$$\sum_{i=1}^{A}\alpha_i\left(\sum_{j=1}^{N_i}K_{ij}\right) + M\left(\{N_i\}_A, A, \sum_{j=1}^{N_i}K_{ij}, \sum_{i=1}^{A}\sum_{j=1}^{N_i}K_{ij}\right) = s(\{N_i\}_A, A)\sum_{i=1}^{A}\sum_{j=1}^{N_i}K_{ij}, \tag{4.2}$$

where

$$s = s\left(\{N_i\}_A, A\right) = 0.113\left(e^{0.03(A-1)} - 1\right) + 0.005\left(\frac{1}{A}\sum_{i=1}^{A}N_i - 1\right), \tag{4.3}$$

shown in Fig. 1, where other choices of s can be made without changing the logic of the argument. When A=1, s increases linearly from s=0 to s=0.25 as N_i increases from 1 to 50. When N_i=1, s increases linearly from s=0 to s=0.25 as A increases from 1 to 40, and increases further to s=0.5 when (A,N_i)=(40,50). In other words, as the company enters into more projects and areas, excess opportunity cost and monitoring costs will increase convexly according to equation 4.3 (illustrated in Fig. 1).

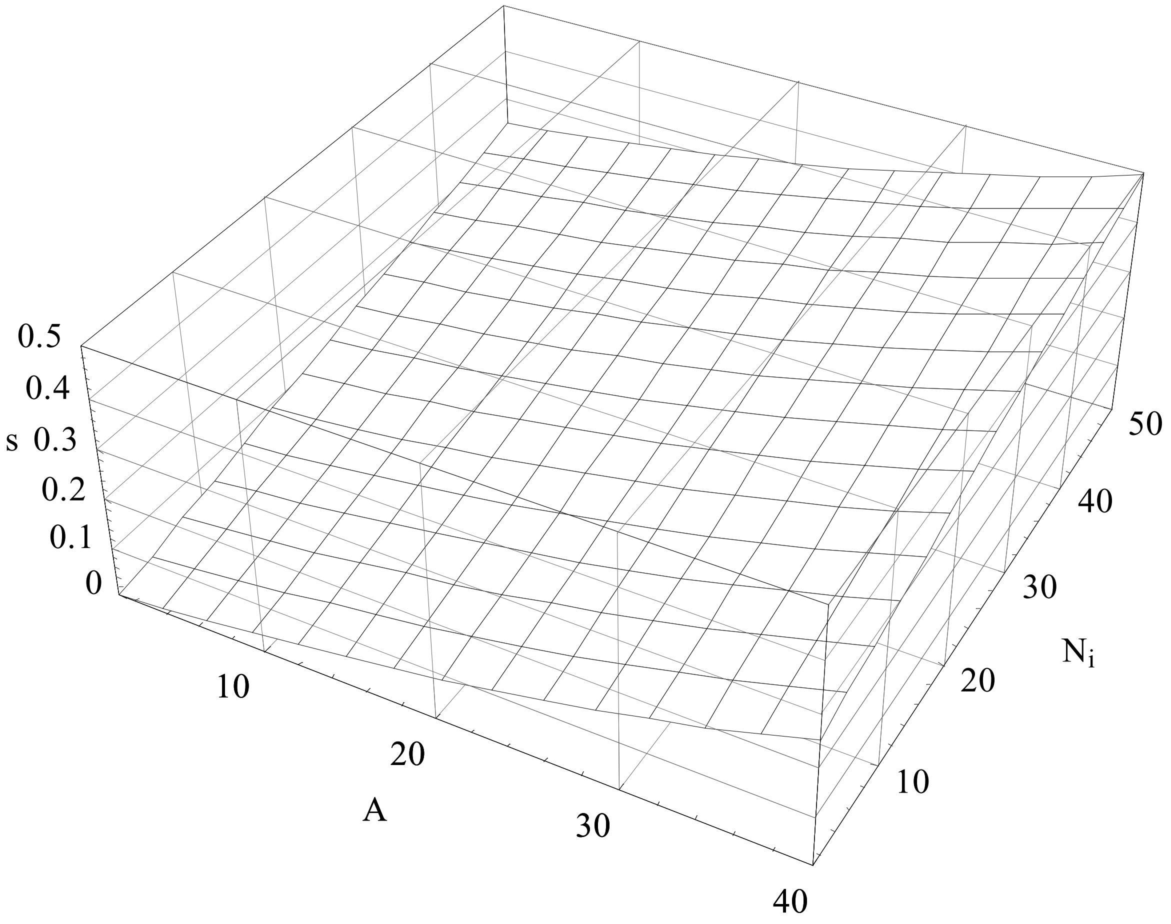

Fig. 1 $s\left(\{N_i\}_A, A\right)$ as a function of A and N$_i$.

We accordingly write (3.1) as

$$R = r\left(\{N_i\}_A, A\right)\left[\sum_{i=1}^{A}\sum_{j=1}^{N_i}\left(PQ_{ij} - K_{ij} - W_{ij}\right) - s\left(\{N_i\}_A, A\right)\sum_{i=1}^{A}\sum_{j=1}^{N_i} K_{ij}\right], \tag{4.4}$$

where $r\left(\{N_i\}_A, A\right)$ and $s\left(\{N_i\}_A, A\right)$ are given by (4.1) and (4.3).

Columns 4-6 in Table 3 show R in (4.4) for A=1,2,3. All the columns in Table 3 reveal the optimality of implementing all projects 12345. In order to illustrate the implementation of more than five projects, we let “a” denote B projects of type 1, i.e. with the same characteristics as project 1, where B is an integer, B≥1. Further, “b” denotes B projects of type 2, “c” denotes B projects of type 3, “d” denotes B projects of type 4, “e” denotes B projects of type 5. “bde” thus refers to 3B projects, B of which are of each of the types 2, 4, 5.

Table 4 lists the 31 different project combinations in column 1 from the left.

	$R(B=9, A=29)$	$R(B=9, A=30)$	$R(B=9, A=31)$	$R(B=61, A=33)$	$R(B=61, A=34)$	$R(B=61, A=35)$
a	54270.9	55472.5	56605.	228974.	229794.	230063.
b	94487.4	96518.4	98423.2	381790.	**382176.**	381553.
c	20531.6	19647.9	18605.3	-284090.	-306715.	-330604.
d	102297.	104227.	105993.	338846.	334654.	329158.
e	52471.6	53379.5	54195.5	151084.	147528.	143238.
ab	139069.	141901.	144536.	40885.1	24821.8	7198.38
ac	62741.2	62598.3	62226.1	-718272.	-760172.	-803887.
ad	144881.	147538.	149959.	-109957.	-133867.	-159633.
ae	98634.8	100415.	102033.	-89370.1	-106331.	-124576.
bc	100094.	100664.	100946.	-732310.	-779701.	-829365.
bd	182234.	185603.	188679.	-123995.	-153397.	-185110.
be	135988.	138481.	140753.	-103408.	-125860.	-150054.
cd	105906.	106300.	106369.	-883152.	-938390.	-996196.
ce	59659.8	59177.6	58443.3	-862565.	-910854.	-961140.
de	141800.	144117.	146176.	-254250.	-284549.	-316885.
abc	131478.	132406.	132978.	-1736371.	-1820306.	-1907066.
abd	213474.	217184.	220532.	-1142677.	-1209065.	-1278318.
abe	171136.	174112.	176800.	-913741.	-966867.	-1022286.
acd	135237.	135916.	136203.	-1995110.	-2090162.	-2188333.
ace	92897.7	92844.6	92470.5	-1766174.	-1847963.	-1932301.
ade	174894.	177623.	180025.	-1172480.	-1236722.	-1303554.
bcd	169461.	170738.	171565.	-2176003.	-2281603.	-2390778.
bce	127122.	127667.	127833.	-1947068.	-2039404.	-2134746.
bde	209118.	212445.	215387.	-1353374.	-1428163.	-1505999.
cde	130880.	131177.	131057.	-2205807.	-2309260.	-2416014.
abcd	187784.	188977.	189652.	-3857840.	-4020522.	-4187333.
abce	149416.	150016.	150168.	-3420556.	-3563662.	-3710325.
abde	231161.	234530.	237446.	-2841483.	-2967485.	-3097084.
acde	151112.	151392.	151188.	-3787192.	-3944684.	-4106029.
bcde	182156.	182923.	183147.	-4134940.	-4308036.	-4485441.
abcde	191455.	**191833**.	191600.	-6286205.	-6530609.	-6779874.

Table 4 PVRI $R(B, A)$ for various project combinations.

The three rightmost columns in Table 4 reveal that it is optimal to implement B=61 projects of type 2 in A=34 areas, with a PVRI $R(B=61, A=34)=382176$. Reading row 3 from the top of Table 4 horizontally toward the right, observe how the PVRI for B=61 projects of type 2 increases to 381790 for A=33, then to 382176 for A=34, and then declines to 381552.[5] It is straightforward to show that deviation to B=60 or B=62 is not optimal. Generally, any deviation from A=34, or deviation from B=61, or deviation to another project combination, is not optimal. The materiality concern is demonstrated through the fact that the project with the highest PVRI, accounting for all costs to the company exemplified by excess opportunity cost and monitoring cost, is the only project implemented in the optimal solution.

Note the flexibility and plasticity of R in (3.1) compared with R^p in (2.2). A variety of concerns with arbitrarily complex characteristics are accounted for by appropriately tuning the parameter values and observing the impact on the PVRI R for the various project combinations. (3.1), exemplified in (4.4), constitutes a flexible tool applicable for arbitrarily complex project data, aiding decision making on which projects in which areas to invest in.

When transcending five projects, not all the five project types, e.g. type 2, may be available in unlimited supply. Let us thus assume that the oil company is constrained to implement an integer number B of packages 12345, expressed as “abcde. This is illustrated in columns 2-4 in Table 4, where it is optimal to implement B=9 project packages abcde in A=30 areas, with a PVRI $R(B=9, A=30)=191833$, as shown in the third lowest row in Table 4. If the oil company can choose not to select one type of project, then project 3 is not selected, and B=14 packages abde are implemented in A=33 areas, with $R(B=14, A=33)=277338$, not shown in Table 4. When two projects may be “unselected”, projects 3 and 5 are not selected, and B=19 packages abd are implemented in A=33 areas, with $R(B=19, A=33)=317147$. Similarly, removing three projects as choices, projects 1, 3, 5 are not selected, and B=28 packages bd are implemented in A=33 areas, with $R(B=28, A=33)=362562$. The optimization is therefore dependant on how many projects of different types are available to the company when it chooses it’s optimal portfolio.

The pre tax analysis have shown that when excess opportunity cost and monitoring cost are accounted for the optimal solution is to choose the most profitable projects and implement

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[5] For B=61 and A=34, R=382176 for type b projects is larger than R=334654 for type d projects, contrary to PQ_{14}-K_{14}-W_{14}=491.9>PQ_{12}-K_{12}-W_{12}=434.4 for B=1 and A=1 in column 4 in Table 3. The reason is excess opportunity costs and monitoring costs, modelled in (4.2) and (4.4) to depend on the capital expenditure K_{ij}, which is larger for type d projects than type b projects, i.e. K_{14}=703.6>K_{12}=544.2 as shown in Table 2.

them N times in A different areas until the marginal benefit of a new project, also accounting for the gain in diversification, is less than the marginal increase in excess opportunity cost and monitoring cost caused by entering into a new project and/or area. This is different from the standard model where all profitable projects in all areas would be implemented.

5 A tax model with A tax regimes

Assuming a marginal tax rate τ_i for area i, (2.2), (3.1), (4.4) become

$$R^p = r\left(\{N_i\}_A, A, \sum_{j=1}^{N_i} K_{ij}, \sum_{i=1}^{A}\sum_{j=1}^{N_i} K_{ij}\right)\sum_{i=1}^{A}(1-\tau_i)\sum_{j=1}^{N_i}\left(PQ_{ij} - K_{ij} - W_{ij}\right), \tag{5.1}$$

$$\begin{aligned} R = r\left(\{N_i\}_A, A, \sum_{j=1}^{N_i} K_{ij}, \sum_{i=1}^{A}\sum_{j=1}^{N_i} K_{ij}\right)&\left\{\sum_{i=1}^{A}(1-\tau_i)\sum_{j=1}^{N_i} PQ_{ij} - \left[K\left(A, \tau_i, \sum_{j=1}^{N_i} K_{ij}, \sum_{i=1}^{A}\sum_{j=1}^{N_i} K_{ij}\right)\right.\right. \\ &+\sum_{i=1}^{A}(1-\tau_i)\omega_i\left(\sum_{j=1}^{N_i} K_{ij}\right) + \frac{\beta_{ij}}{K_{ij}}\sum_{i=1}^{A}(1-\tau_i)\sum_{j=1}^{N_i} K_{ij} + \sum_{i=1}^{A}(1-\tau_i)\sum_{j=1}^{N_i}\gamma_{ij} \\ &\left.\left.+\sum_{i=1}^{A}\alpha_i\left(\sum_{j=1}^{N_i} K_{ij}\right) + M\left(\{N_i\}_A, A, \sum_{j=1}^{N_i} K_{ij}, \sum_{i=1}^{A}\sum_{j=1}^{N_i} K_{ij}\right)\right]\right\}, \end{aligned} \tag{5.2}$$

$$R = r\left(\{N_i\}_A, A\right)\left[\sum_{i=1}^{A}(1-\tau_i)\sum_{j=1}^{N_i}\left(PQ_{ij} - K_{ij} - W_{ij}\right) - s\left(\{N_i\}_A, A\right)\sum_{i=1}^{A}\sum_{j=1}^{N_i} K_{ij}\right]. \tag{5.3}$$

Table 5 shows how a uniform tax rate of $\tau_i = 0.75$ across all areas reduces the optimal numbers of projects and areas. This is the result of lower after tax PVRI which due to the non tax deductible costs of excess opportunity cost and monitoring cost reduces the companies optimal number of areas and projects. Some monitoring cost may be tax deductible but our argument would still hold.

	$R(B=2, A=12)$	$R(B=2, A=13)$	$R(B=2, A=14)$	$R(B=15, A=14)$	$R(B=15, A=15)$	$R(B=15, A=16)$
A	1192.21	1253.31	1307.1	5660.1	5701.48	5680.67
B	2074.36	2177.23	2266.72	9400.86	**9407.65**	9300.72
C	422.282	368.087	297.039	-7831.11	-9250.23	-10812.5
D	2240.03	2335.87	2414.38	8173.77	7892.78	7464.65
E	1147.23	1191.65	1226.32	3581.37	3349.31	3034.43
ab	3070.88	3218.95	3346.22	650.692	-360.239	-1547.97
ac	1374.09	1360.53	1322.61	-19134.3	-21746.9	-24564.4
ad	3196.87	3334.49	3447.33	-3345.	-4844.74	-6554.55
ae	2176.2	2268.31	2343.26	-2659.96	-3723.45	-4932.43
bc	2198.52	2222.	2215.02	-19619.3	-22576.7	-25790.6
bd	4021.3	4195.95	4339.75	-3830.02	-5674.52	-7780.84
be	3000.63	3129.78	3235.67	-3144.98	-4553.24	-6158.72
cd	2324.51	2337.54	2316.14	-23615.	-27061.2	-30797.2
ce	1303.84	1271.36	1212.06	-22930.	-25939.9	-29175.1
de	3126.62	3245.32	3336.79	-7140.67	-9037.74	-11165.3
abc	2947.89	2995.04	3004.1	-45530.	-50718.4	-56223.8
abd	4774.25	4973.35	5134.	-30071.5	-34177.3	-38605.3
abe	3827.34	3987.12	4116.11	-24047.	-27332.6	-30876.2
acd	3033.66	3066.88	3058.	-52300.9	-58176.3	-64401.6
ace	2086.76	2080.65	2040.11	-46276.4	-51331.6	-56672.5
ade	3913.12	4058.96	4170.01	-30817.9	-34790.4	-39054.
bcd	3799.05	3864.36	3881.43	-57061.7	-63589.5	-70518.5
bce	2852.15	2878.13	2863.55	-51037.3	-56744.8	-62789.4
bde	4678.51	4856.44	4993.45	-35578.8	-40203.6	-45170.9
cde	2937.93	2949.97	2917.45	-57808.2	-64202.6	-70967.2
abcd	4299.31	4366.85	4378.38	-100360.	-110355.	-120813.
abce	3427.54	3462.15	3448.47	-88989.1	-97782.2	-106974.
abde	5256.2	5443.27	5581.68	-73893.4	-81632.5	-89775.1
acde	3472.67	3489.81	3454.63	-98531.6	-108209.	-118318.
bcde	4177.92	4222.03	4207.64	-107574.	-118210.	-129328.
abcde	4500.01	**4530.82**	4495.27	-162899.	-177862.	-193370.

Table 5 PVRI $R(B, A)$ for various project combinations, $\tau_i = 0.75$.

Table 5 reveals that it is optimal to implement B=15 projects of type 2 in A=15 areas, with a PVRI $R(B=15, A=15) = 9407.65$. When constrained to implement an integer number of packages 12345 due to not enough projects of different types being available, this will be done with B=2 projects (of type 12345) in A=13 areas, with a PVRI $R(B=2, A=13) = 4530.82$. If one project can be unselected, project 3 is not selected, and B=3 packages abde are implemented in A=15 areas, with $R(B=3, A=15) = 6670.64$, not shown in Table 4. Unselecting projects 3 and 5 gives the optimal $R(B=5, A=14)=7744.91$ and being able to not choose three project types (1, 3, 5) gives $R(B=7, A=14)=8855.55$.

Like the pre tax analyses the optimal portfolio will consist of a limited number of areas and projects depending on the availability of project types in the different areas. The optimal solution however, will be more limited in areas and projects than the pre tax analyses due to the fact that excess opportunity cost and monitoring cost are treated as not tax deductible.

6 A tax model with two tax regimes

Assuming a number A_H of high-tax areas with tax rate τ_H and PVRI R_H, and a number A_L of low-tax areas with tax rate $\tau_L < \tau_H$ and PVRI R_L, (5.3), (4.1), (4.3) become

$$R = R_H + R_L = r\left(\{N_i\}_{A_H,A_L}, A_H, A_L\right)\left[(1-\tau_H)\sum_{i=1}^{A_H}\sum_{j=1}^{N_i}\left(PQ_{ij}-K_{ij}-W_{ij}\right)\right.$$
$$\left.+(1-\tau_L)\sum_{i=A_H+1}^{A_H+A_L}\sum_{j=1}^{N_i}\left(PQ_{ij}-K_{ij}-W_{ij}\right)-s\left(\{N_i\}_{A_H,A_L}, A_H, A_L\right)\left(\sum_{i=1}^{A_H}\sum_{j=1}^{N_i}K_{ij}+\sum_{i=A_H+1}^{A_H+A_L}\sum_{j=1}^{N_i}K_{ij}\right)\right], \tag{6.1}$$

$$r = r\left(\{N_i\}_{A_H,A_L}, A_H, A_L\right) = \left(1.05-0.05e^{-0.006\left(\sum_{i=1}^{A_H+A_L}N_i-1\right)}\right)\left(\frac{105}{100}-\frac{5}{100}e^{-0.4(A_H+A_L-1)}\right), \tag{6.2}$$

$$s = s\left(\{N_i\}_{A_H,A_L}, A_H, A_L\right) = 0.113\left(e^{0.03(A_H+A_L-1)}-1\right)+0.005\left(\frac{1}{A_H+A_L}\sum_{i=1}^{A_H+A_L}N_i-1\right), \tag{6.3}$$

as illustrated in Table 6.

High	abcde	abde	abde	Abde	abde	abde	abde
Low	0	0	"c": 75%	c: 50%	c: 50%	c: 50%	c: 50%
B_H	2	2	2	2	2	2	2
A_H	13	13	13	13	13	13	13
B_L	0 (lock)	0 (lock)	"1" (lock)	1 (lock)	50 (opt)	5 (lock)	8 (lock)
A_L	0 (lock)	0 (lock)	"1" (lock)	1 (lock)	1 (opt)	1 (opt)	2 (opt)
R	4530.82	5443.27	5303.58	5357.5	5990.38	5456.4	5538.7
R_H	4530.82	5443.27	5312.95	5312.95	4393.32	5238.75	4913.33
R_L	0	0	"-9.37035"	44.5489	1597.06	217.647	625.368
R	1.07378	1.07378	1.07409	1.07409	1.08125	1.07476	1.0766
S	0.0839662	0.0839662	0.0863988	0.0863988	0.103899	0.0878274	0.0939817
Col.	2	3	4	5	6	7	8

Table 6 Characteristics of two tax regimes, where $\tau_H = 0.75$ and $\tau_L = 0.5$.

Column 2 in Table 6 assumes as a benchmark implementation of B_H=2 project packages abcde in A_H=13 high-tax areas with rate $\tau_H = 0.75$, in accordance with column 3 in Table 5, with no implementation in low-tax areas, i.e. B_L=A_L=0 ("locked" to zero). This gives a PVRI R=4530.82. When allowed not to select project 3, the oil company will do so earning the higher R=5443.27, as shown in column 3 in Table 6, and also in column 3 in Table 5 (fourth lowest row). The upper ceilings of B_H=2 and A_H=13 cause no incentive to drop other projects. R=5443.27 is thus a benchmark for the high-tax areas when locked to implementing B_H=2 project packages abde in A_H =13 high-tax areas with rate $\tau_H = 0.75$.

A hypothetical consideration in column 4 is implementing project 3 once in an eleventh high-tax area ($"\tau_L" = 0.75$), giving the lower R=5303.58, which is the sum of R_H=5312.95 (for the high-tax area, where B_H=2, A_H=13; R_H declines since s increases, while r increases marginally) and "R_L"=-9.37035 (for the eleventh area, where "B_L"=1, "A_L"=1, where quotation marks are used since "L" in column 4 does not refer to a high tax area. Closer scrutiny reveals that the oil company does not want to implement any number of project 3 in any number of high-tax areas due to the high tax rate $\tau_H = 0.75$. Column 5 shows that reducing the tax rate in the eleventh area to $\tau_L = 0.5$, and implementing project 3 once in this area (B_L=A_L=1), causes R=5357.5, which is lower than R=5443.27. The increasing excess opportunity costs and monitoring costs do not provide sufficient incentive to implement project 3 only once in one low-tax area. However, column 6 reveals that when given an unlimited supply of projects of type 3 in an unlimited number A_L of low-tax areas with rate $\tau_L = 0.5$, adjustment to B_L=50 and A_L=1 is optimal (opt) giving R=5990.38.

Supply of projects is usually not unlimited. In order to enter one new low-tax area, the company needs access to at least B_L=5 projects of type 3, with R=5456.4 (column 7), marginally higher than R=5443.27. When there are a minimum of B_L=8 projects of type 3 available in more than one area, the company finds A_L=2 areas optimal, with R=5538.7 (column 8). Implementing projects of type 3 in more than two low-tax areas is never optimal with these parameter values.

The results of the analysis with different tax regimes explain why some oil companies elect to enter areas with seemingly less profitable projects. If the pre tax present value of residual income is low, taxes need to be curtailed to the profitability of the particular industry. The optimal choice combination depends again, however, on the availability of project types to the company, and the size of the after tax present value of residual income where excess opportunity costs and monitoring costs are included. Materiality, the size of the present value of residual income, is therefore crucial for the choice of strategic core and portfolio selection when all costs to the company are considered. In our case this was illustrated by including excess opportunity costs and monitoring costs in addition to the standard project specific costs.

7 Discussion and future work

Oil companies are sometimes questioned on why they turn down projects that apparently seem profitable. Some speculate that oil companies withdraw from apparently profitable projects as a strategy in order to achieve certain tax breaks or other incentives. This article suggests that there exist other reasons for rejection of profitable projects. It is illustrated how oil companies actually go about in their selection of which countries and the number of countries to invest in, and which projects to implement. An analytical framework is provided for how companies decide which and how many projects to initiate, and how many areas (countries) to be involved in. We demonstrate how financial volume is decisive for companies investment allocation decision when monitoring cost and excess opportunity cost are included. For tax policy the implication is that taxes need to be curtailed to the profitability of the particular industry.

We believe that the phenomena explained in this article are widespread also outside the oil industry. One example is the Hollywood film industry assessing which movies to shoot and which movie stars and directors to employ. Rising or falling stars and directors, and scripts produced by unknown authors, are evaluated against established stars/directors (e.g. Tom Cruise, Bruce Willis, Sharon Stone, Steven Spielberg) and well-known authors of scripts. Due to excess opportunity cost and monitoring costs only "packages" with sufficiently high expected PVRI are chosen. Another example is the airline construction industry determining what kinds of airplanes to initiate research on and construction of. Complex evaluations of market conditions for air travel, consumer preferences for comfort/speed/safety, costs of construction and subsequent maintenance, and buyer characteristics/capacity play a role, where only airplanes generating substantial net present values are likely to be produced due to excess opportunity cost of personnel and monitoring cost. A third analogy is companies or projects that are making accounting profit but are discontinued due to materiality considerations because not all cost to the company or project appear in the accounting statements.

8 Conclusion

Recent trends among major oil companies and independents have been consolidation through mergers and acquisitions and focus on key strategic core areas. The expressed goals have been to achieve synergy, reduce costs, and concentrate on areas with maximum expected value creation. The article provides a model that determines endogenously the optimal number of projects to implement in an optimal number of areas. The decision of whether to invest in a project cannot be seen in isolation but must be linked with portfolio optimization and the strategic core of the firm. The organizational separation of portfolio analysis and strategic decision making in oil companies is partly merged by accounting for excess opportunity cost and monitoring cost directly in the model. An analytical framework is provided where oil companies decide which countries and the number of countries to be involved in, and what projects and the number of projects to implement. Accounting for excess opportunity costs and monitoring costs, we demonstrate how financial volume, i.e. materiality, is decisive for companies' investment allocation decision. The impact of different tax regimes on the decision is analysed. Excess opportunity costs and monitoring costs operate such that although implementing one or several marginally profitable projects in a high tax area may not be profitable, implementing a minimum number of marginally profitable projects in one or several low-tax areas may be optimal.

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