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Abstract

When making international capital budgeting decisions, energy companies are often faced with capital and organisational constraints. The constraints may be real or management imposed. In addition, when entering into a new country or region the companies will incur fixed new area costs that must be considered before investment approval. The decision problem is therefore not a linear problem where the standard net present value rule applies, but a non-linear problem of selecting the combination of projects with the maximum aggregate net present value. New project investments will therefore be selected based on the size of the net present value (often referred to as financial volume or materiality) compared to the projects' use of capital and scarce personnel and organisational capacity. Consequently, projects with a positive net present value, but with low materiality, may not be approved. The portfolio choice has a parallel to the company's choice of core areas. Instead of complex portfolio models, the companies often apply simpler allocation mechanisms, e.g., combinations of fixed investment budgets and materiality requirements. Analysing petroleum cases, we compare the allocations decisions generated by portfolio models and simpler mechanisms. We also discuss the implications of this capital allocation pattern for governments' design of tax systems and license conditions.

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1. Introduction

Because fixed area costs will incur when entering into a country or new area, the size of the expected net present value (materiality) of E&P investments must be substantial enough to cover these costs. If the new project itself is not able to cover the area costs, the company must then expect a sufficient net present value potential from other projects in the country or area. The combination of fixed area cost and company resource constraints emphasises the importance of the materiality of the expected net present value for the company capital budgeting decision. The materiality issue therefore not only becomes an issue for the investing company, but also an issue for governments in countries possessing exhaustible natural resources, interested in attracting and maintaining corporate investments. Thus, our analyses are of interest both for portfolio managers and tax authorities.

Since materiality is the size of the net present value of the project after tax, and traditional valuation by companies is defined as the discounted cash flow method, materiality becomes a function of expected after tax cash flow and the discount rate. The expected after tax cash flow is related to the size of the project itself, the company's equity share in the project and the tax level. The discount rate is the appropriate required rate of return dependent on the systematic risk (non diversifiable risk) of the project. Consequently, company approval of an investment will depend on the perceived risk of the project (the non diversifiable portion), the project size, the company's equity share and the tax level. In addition to these materiality variables companies are aware that there might be option values related to projects. Option value(s) are therefore an additional materiality variable that might affect companies' investment incentives.

In the paper we examine the materiality requirement with the standard net present value method in a setting with company constraints and fixed area costs. Using real project oil exploration data obtained from the oil industry it will be demonstrated how materiality will be important for company capital allocation decisions when company constraints and fixed country costs are included in the analysis. Data and illustrations are from the Norwegian Continental Shelf, but the insights are of a general nature. The results might help explain the recent strategy trend by oil exploration companies to focus their activity in particular geographic areas where the materiality conditions are favourable. Consequently, materiality is an important factor in order for countries to be competitive and attract foreign investments. Due consideration of materiality must therefore be taken when governments are making policy decisions regarding the energy industry.

2. Materiality

Materiality is a concept which is linked to selection of investment projects when the company has a given investment budget and limited resources in the form of management and employees with specialised competence. Materiality - also referred to as financial volume or critical mass - implies that projects need to be above a certain size (in terms of after-tax net present value) in order for them to be interesting to multinational oil companies. A small project can be unattractive even if it is able to show a high expected return (internal rate of return).

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 there to be a certain critical mass in connection with investment decisions. The petroleum companies' increasing materiality requirement is closely connected with their focusing strategies. They concentrate scarce resources on fewer activities, focus 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. 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. There is an increasing recognition 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.[1] One may envisage far more sophisticated methods by which to rectify this problem, but simple, implementable management systems are often the preferred solution by companies.

Materiality requirements may also follow directly from traditional economic decision analysis, if one recognises the fact that the real decision problem is non-linear and non-divisible, with a number of scarce factors and fixed costs. In the investment cases presented below, materiality and its importance in practical decision making is illustrated. We employ data from actual petroleum projects on the Norwegian Continental Shelf. The insight into materiality is general, however, and may appear in a more conventional model. The materiality result does thus not depend on our specific assumptions regarding price

[1] See for instance Zimmerman (1979).

development, discounting interest 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 the fixed area-dependent costs are low. However, in view of the petroleum companies' focusing strategy, there is reason to believe materiality considerations play a central role in the companies' allocation and localisation decisions.[2]

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. The taxation never reach 100 per cent, 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 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 a description of international tax and fiscal competition, see Zodrow and Mieszkowski (1986), Gresik (2000), and Olsen and Osmundsen (2000).

3. Non-linear optimisation

Materiality is not modelled in elementary investment analysis or in existing taxation theory. These models consider capital to be the primary scarce factor, in which case the internal rate of return becomes the relevant decision-making criteria. In conventional examples based on internal rate of return, however, a number of simplifying and unrealistic assumptions are made. One assumes that other scarce factors are fully reflected in prices, one assumes full divisibility of projects and that all relevant costs are included in the calculation. In reality, there is 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

[2] Wood Mackenzie (1999) point this out.

[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.

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, look at 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. An analytical approach to this decision problem will be 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, one often uses simpler decision-making tools. One important reason is that recommendations and often decisions are made, not 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.

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 level of activity and costs of restructuring, one is reluctant 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.

4. Factors determining the materiality of a project

Materiality can be analysed at two main levels: 1) project level, and 2) basin level. Both issues 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.

The fact that there in a mature area gradually will be vacant capacity within processing and pipeline transportation as established fields are phased out, may make it highly profitable to develop satellite fields. This presupposes that one is able to keep down the costs of operation and maintenance on old production facilities. However, in some new potential discovery areas, one is facing problems with long distances from existing infrastructure.

Tightened cost control in development projects will also be of importance for the profitability of new field developments.

Other factors influencing materiality, both at 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 by the fact that companies most often hold a limited equity share 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 NPV to each company. The internal rate of return, however, remains unchanged provided the company is in a tax paying position. Taxation does thus not reduce the profitability of the investment, but is instrumental in scaling down the project for each individual company. This reduces net present value after tax and thus the materiality of the project. The scheduled 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.

There is reason to distinguish between localisation decisions faced by the company *before* and *after* they have built up a substantial organisation, infrastructure and specific competence in a certain producing nation. A company that has been present in a country for a long time and acquired substantial local competence that may not have the same value in a different country. The company then have a number of irreversible investments that are immobile. The materiality consideration will therefore be different before and after a substantial activity has been established. This works in the favour of established producing nations. This argument however, should not be overvalued since mobility can still be high to the extent that there is a second-hand market for oil leases and infrastructure. Also, there might be substantial area-dependent annual (avoidable) fixed costs associated with being established in a country.

Interesting to note, for governments, is that companies differ in their materiality requirements, with large companies typically having a higher demand for financial volume in projects than smaller companies. Thus, governments may be able to keep a larger share of the resource rent if they attract smaller petroleum companies. This is a policy currently pursued by Norwegian authorities. However, large and small companies differ in their financial

strength and technical competence, and the authorities would have to trade off price (demand for financial volume) against quality (e.g., resource extraction rate). We may expect to see a division of labour between larger and smaller companies, with the former developing larger reservoirs at deep water, whereas the latter focus on smaller, stand-alone reservoirs and tail extraction.

5. The behavioural hypotheses of tax theory

Economic tax theory typically presumes that a company will realise any project with a positive net present value (materiality is irrelevant).[5] If the capital is scarce, the company will allocate its investments where the profitability (internal rate of return) is highest. According to these behavioural assumptions[6], the fact that the company's cash flow is scaled down, should have no negative impact on the investment decision. However, somewhat more sophisticated portfolio investment theory does not prescribe the use of internal rate of return as decision-making criterion, but rather the use of portfolio models to arrive at the portfolio of projects with the largest accumulated present value to the company (with consideration paid to resource and capital constraints). This theory is also more in line with company practise.[7] Several scarce factors, fixed costs and divisibility problems may favour projects with good materiality. It will therefore be of interest to extend the existing tax models so as to capture materiality considerations. The general tax implications of materiality, if not the detailed tax design, however, are clear also without the use of formal models. In order to secure the participation of competent companies one must - in situations of reduced expected basin profitability - give the companies higher equity shares and gradually lower average tax for new fields. This is simply to state that the tax and licensing conditions must be curtailed to the present level of resource rents generated.

6. Case analysis

Based on exemplifying project cases, the effect on project decisions of capital constraint, organisational constraints and project-external corporate costs will illustrated by project data from the Norwegian Continental Shelf. We use oil project data received from Statoil, and

[5] See, e.g., Atkinson and Stiglitz (1980).
[6] This neutrality property is only valid if we can ignore the probability that the company, for instance due to low oil prices, falls out of tax position, or if the tax system has perfect loss offset. These conditions are not satisfied in practice.
[7] Simplified approaches - like NPV per unit of scarce factor - is in some companies used to rank investment opportunities.

used previously in Emhjellen (1999) and Emhjellen and Alaouze (2000). Table 1 shows expected production, investments and operating costs for 5 different oil projects.

6.1 Assumptions and calculations

Revenues are based on a real oil price of USD 15 per barrel. The reason why a real oil price of USD 15 has been chosen as the basis for calculation of incomes is that, despite a very high oil price at the moment, this price assumption is more in line with the oil companies' long-term expectations. The company is assumed to be one hundred percent equity-financed and to require a10 percent real return on capital after tax. The results prove to be robust with respect to assumptions on oil price and required return on capital.

It is assumed for illustrative purposes that the project portfolio of these five petroleum projects is available in two different countries. The purpose of assuming identical projects in pairs in the two countries is to separate out the effects of geological prospectivity and cost level, to be able to isolate the effects of tax and licensing policy. Calculations are therefore shown for a total of 10 projects, of which projects 1 to 5 are in country 1, whereas projects 6 to 10 are in country 2. Project 1 in country 1 corresponds to project 6 in country 2, project 2 in country 1 is identical to project 7 in country 2, and so on. In country 1, we assume the existence of strict fiscal conditions with an equity share of 20% and an effective marginal tax rate of 75%, whereas for country 2, we assume more favourable framework conditions with an equity share of 50% and a marginal tax rate of 40%. The calculation of tax is simplified - in order to be able to focus on aspects of materiality - by assuming the tax is paid on the pre-tax cash flow and that the company, in the case of a negative pre-tax cash flow - is able to consolidate this negative cash flow against other income in the company. The project thus has a positive tax effect in the case of a negative cash flow before tax. Shown in table 2 are cash flow before tax, cash flow after tax and present value for each project in country 1. As shown by the results in table 2, the net present value parameter in country 1 varies from USD 6.2 million (project 3) to USD 17.7 million for project 2. Similarly, table 3 shows the results in country 2. The net present values in country 2 are varying from USD 37.3 million (project 8) to USD 106.2 million (project 7). Due to a higher equity share and lower tax rate, the present values are generally higher in country 1. However, the internal rate of return is equal in the two countries. With a fully linear tax system (negative tax possible), the State carries an equal portion of expenses as it captures of incomes. Return on investments is thus not influenced by taxes. Based on standard assumptions in tax theory, such a tax system will not influence the

investment allocation. We will, however, show that this standard assumption does not hold if the company is facing constraints and fixed area costs.

6.2 Results

Table 4 sums up net present value and the sum of investments for the projects based on the project data and assumptions. Column 1 shows project number, column 2 shows tax rate, column 3 shows internal rate of return (equal for all), column 4 shows net present value in USD, column 5 shows equity share in project and column 6 shows the sum of investments.

As illustrated by the table, internal rate of return is equal between the pair-wise projects in country 1 and country 2. However, the net present value of the projects is substantially lower (yet positive) in country 1 as a result of a higher tax rate and a lower equity share (weaker materiality). Without any sort of capital constraint or materiality evaluations, i.e., a linear decision-making situation, all projects would be approved by the oil company.

6.2.1 Capital constraint

As an essential part of their finance management, transnational petroleum companies are often operating with investment budgets. These work as efficient constraints on investment decisions. Two different designs of capital budgets are being employed, in which maximum investment amount can be calculated either in the form of pre-tax or after-tax values.

(a) After-tax capital constraint

A constraint in after-tax investment amount is a rational option if capital constitutes the only scarce factor. By making calculations after tax, one will capture the circumstance that the State is, in fact, carrying a substantial part of the investment cost if the company is in tax-paying position (or if one has a fully linear tax system). When setting out to rank projects, one will look at returns after tax, viewed in relation to after-tax investment amount, i.e., maximising the value per scarce factor. One fraction often computed is referred to as The Present Value Index (PVI). Internal rate of return will not work as a ranking criterion because one does not capture the time dimension (a project with high profitability for twenty years may be better than a project having a higher return but which is of shorter duration). Since we typically have large-scale non-divisible projects (non-linear optimisation), it is not certain that one will be able to use the entire capital available. Also, with binding capital constraint(s),

some projects with positive present values will typically not be realised. High-tax countries will not perform worse than low-tax countries, in this setting, if both countries have neutral tax systems.

(b) Pre-tax capital constraint

Some transnational petroleum companies are operating with binding investment budgets on a pre-tax basis. These do not capture the circumstance that the company will cover a lower share of the investments in high-tax countries. The capital constraint will, in other words, bind more strongly in such countries since one includes tax in the calculation of cash flow excluding investments (in the present value index, one makes allowance for tax in the numerator but not in the denominator). Such a system for allocation of investment funds must be taken to mean that capital is not really what constitutes the scarce factor of the company, but rather that investments before tax are a proxy for other company scarce factors, e.g. professionals or managerial capacity. As shown below, this allocation mechanism also gives similar project rankings as if one had been operating with more explicit constraints on other scarce factors. The latter approach would be more difficult to implement, though, explaining why fixed capital budgets are often used. The rationale of having an investment budget on a pre-tax basis is that this serves to best reflect the magnitude and occupation of scarce resources of the projects. A project in a country with a high marginal tax calls for just as many professionals and just as much administrative follow-up as a project in a country with a low marginal tax.

Below we illustrate the effects of introducing capital constraint in the form of an investment constraint, where the sum of investments before tax shall not exceed USD 1.4 billion. In table 5, we can see how an oil company will maximise portfolio present value given the constraint on investment level. The oil company will now select the portfolio composition giving the highest accumulated present value. In table 5, we can read under column 7 that this causes projects 2 to 5 (country 1) not to be approved for implementation and project 8 (country 2) not to be approved, because of too weak materiality. The total investment constitutes USD 1376.8 million and the total present value constitutes USD 340.4 million.

As a consequence of the capital constraint of USD 1.4 billion for investments, country 1 with the highest marginal tax and the lowest equity share will not be competitive compared to country 2. In country 1 only one project is included, whereas all projects except for project 8 are approved in country 2. Sensitivity calculations performed with an oil price of USD 13

and 17 per barrel show that the above results do not change within this oil price interval. Also, a change in the required real rate of return within the interval 8-12% does not change the results.

6.2.2 Organisational constraint

Organisational constraint is here defined as an internal constraint in the company which causes the management to initiate only a limited number of projects. Table 6 shows an example in which an organisational constraint is illustrated by allowing the company to only have 7 qualified project managers available. There may, in real-life situations, be a scarcity of many types of professionals. Table 6 therefore only shows a simplified example. Many simultaneous development projects with management and controller resources scattered over a large number of projects, is one of the factors explaining the recent years cost overruns on the Norwegian Continental Shelf. It is, for the sake of simplicity, assumed that each development requires a separate project manager. As can be seen from the table, projects 1, 3 and 5 in country 1 with the lowest after-tax present value will not be approved as a consequence of this constraint. This illustrates the importance of materiality in connection with organisational constraints.

Sensitivity calculations performed with an oil price of USD 17 per barrel or a change in the required real rate of return within the interval 8-12% does not change the above results. However, with an oil price of USD 13 per barrel the net present value of project 8 turns negative (USD -7,6 million) while the net present value of project 1 is reduced to USD 6,7 million. Project 8 is consequently not included because it is more oil price sensitive than project 1. The country with the highest materiality, however, still receives the majority of the investments.

6.2.3 Company costs

As mentioned above, company costs can be of decisive importance in connection with materiality evaluations. The reason for this is that there often are company costs involved in initiating new projects, when establishing new offices in new areas or countries or when continuing activity in a country. These are costs which are usually not included in the anticipated cash flow for a project but which are important when an investment decision is to be made. Examples of company costs may be use of resources in the form of man-hour costs by corporate staff, travels made by corporate staff and management, and the establishment and operation of a head office. When expected materiality is relatively low, even limited

company costs may cause the company not to elect to venture into a new country or area. It may also result in rejection of a new project in an existing area, or possibly a total shutdown of the activity in an area.

Below we calculate two cases. One where company costs fully reduces taxable income in the two countries (Table 8) and one where the costs are not deductible (Table 7). In reality the most likely case would be somewhere in between these assumptions, and varying from country to country. Some company costs may reduce taxable income locally while other company costs, like ”overheads” in the mother company, may be harder to get approved for local tax deduction. Calculated costs for use of scarce management resources will typically be difficult to deduct. The company costs are assumed to be equally distributed between the five projects (USD 2 million on each). The example illustrated in table 7 assumes a company cost of USD 10 million per year as a consequence of venturing into or staying on in country 1 and a similar cost for country 2. The company costs are assumed not to reduce taxable income in the two countries.

Table 7 shows that in country 1 only project 2 still has a positive net present value. However, an overall evaluation of the present value potential in country 1 causes the company not to be able to initiate or uphold activity in country 1. The overall activity is unable to cover the area-dependent costs. The conclusion that can be taken on the basis of table 7 is that the company must have relatively high materiality in the form of anticipated present value after tax in its project calculations (i.e., excluding company costs) before it is willing to venture into a new country or area, or a new project in an existing area. When consideration is paid to fixed company costs, materiality becomes important for the decision. Sensitivity calculations performed with an oil price of USD 13 show that project 8 will not be profitable. At high oil price (USD 17) country 1 is close to becoming interesting due to higher net present values in the projects. A sensitivity with a low required return (8%) also make country 1 interesting. With a required return of 12% the main results in Table 7 are not changed. As shown, the materiality conditions in the form of ownership share is important. The ownership share must be large enough to cover the company costs.

In the case that company costs can fully reduce taxable income, the results in Table 8 show that the projects in country 1 will not have negative net present value before company costs exceed USD 35 million per year, compared to only 10 million in the Table 7. The reason

for this is the assumption of a linear tax system where the State covers the tax part of all costs.[8]

7. Conclusion

The examples demonstrates that each of the three possible causes of materiality – capital constraint, organisational constraint and company costs – may be sufficient for a project's or area's materiality to be important for decision-making purposes. In real-life situations several of these constraints may bind simultaneously thereby reinforcing the importance of materiality for the companies investment and localisation behaviour. Sensitivity analyses indicate that the materiality results are robust. They illustrate the general result that investments go where materiality conditions are favourable. Thus, materiality considerations are therefore essential for governments in order for their countries to stay competitive and attract investments.

In our analysis we have assumed that the company's scarce inputs are homogenous. If there are quality differences between different inputs, for instance professionals or management, an additional quality distortion in favour of the country with high materiality is introduced. The best resources will be allocated where the potential gain is largest.

In our case illustration of corporate costs, we obtained the result that the activity level was fluctuating with the oil price level in the country offering low license shares and high taxes. This country was only able to attract investments when the oil price was high. A strongly fluctuating activity level may make it difficult to develop or maintain a national oil industry.

[8] Again, it should be noted that the company must be in tax paying position.

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Project data

Table 1 Project data.

	Project 1			Project 2			Project 3		
Yr	Oil production	Real inv. cost	Real oper. cost	Oil production	Real inv. cost	Real oper. cost	Oil production	Real inv. cost	Real oper. cost
	Mill.bbl.	$mill.	$mill.	Mill. bbl.	$mill.	$mill.	Mill. bbl.	$mill.	$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	Real inv. cost	Real oper. cost	Oil production	Real inv. cost	Real oper. cost
	Mill. bbl.	$mill.	$mill.	Mill. bbl.	$mill.	$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			

As illustrated by the table, 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.

Table 2 Cash flows and present values in country 1

	Project 1		Project 2		Project 3	
	Real b/tax CF (project)	Real a/tax CF (company)	Real b/tax CF (project)	Real a/tax CF(company)	Real b/tax CF (project)	Real a/tax CF (company)
Yr	$mill.	$mill.	$mill.	$mill.	$mill.	$mill.
Sum		**11,2**		**17,7**		**6,2**
1	-7,6	-0,4			-4,3	-0,2
2	-99,2	-5,0	-9,5	-0,5	-98,5	-4,9
3	-127,8	-6,4	-61,3	-3,1	-475,7	-23,8
4	82,1	4,1	-302,0	-15,1	-222,6	-11,1
5	171,2	8,6	-141,5	-7,1	131,3	6,6
6	173,2	8,7	295,7	14,8	231,6	11,6
7	165,8	8,3	392,0	19,6	280,7	14,0
8	91,6	4,6	309,8	15,5	275,5	13,8
9	36,7	1,8	218,0	10,9	239,7	12,0
10	16,4	0,8	141,9	7,1	144,3	7,2
11			77,8	3,9	97,1	4,9
12			47,4	2,4	64,2	3,2
13					45,6	2,3
14					35,0	1,8

	Project 4		Project 5	
	Real b/tax CF (project)	Real a/tax CF (company)	Real b/tax CF (project)	Real a/tax CF (company)
Yr	$mill.	$mill.	$mill.	$mill.
Sum		**16,1**		**9,8**
1				
2	-184,8	-9,2	-126,7	-6,3
3	-193,2	-9,7	-168,8	-8,4
4	-253,2	-12,7	-203,5	-10,2
5	-25,4	-1,3	151,9	7,6
6	16,4	0,8	194,6	9,7
7	120,1	6,0	196,8	9,8
8	228,4	11,4	195,9	9,8
9	175,3	8,8	195,0	9,8
10	188,2	9,4	124,8	6,2
11	227,0	11,4	64,3	3,2
12	227,0	11,4	35,6	1,8
13	227,0	11,4	19,9	1,0
14	227,0	11,4		
15	227,0	11,4		
16	227,0	11,4		
17	227,0	11,4		
18	227,0	11,4		
19	104,6	5,2		

Table 3 cash flow and present values in country 2

Yr	Project 6 Real a/tax CF (comp.) $mill.	Project 7 Real a/tax CF (comp.) $mill.	Project 8 Real a/tax CF (comp.) $mill.	Project 9 Real a/tax CF (comp.) $mill.	Project 10 Real a/tax CF (comp.) $mill.
Pr.value	**67,5**	**106,2**	**37,3**	**96,5**	**58,9**
Sum					
1	-2,3		-1,3		
2	-29,8	-2,9	-29,6	-55,4	-38,0
3	-38,3	-18,4	-142,7	-58,0	-50,6
4	24,6	-90,6	-66,8	-76,0	-61,1
5	51,4	-42,5	39,4	-7,6	45,6
6	52,0	88,7	69,5	4,9	58,4
7	49,7	117,6	84,2	36,0	59,0
8	27,5	92,9	82,7	68,5	58,8
9	11,0	65,4	71,9	52,6	58,5
10	4,9	42,6	43,3	56,5	37,4
11		23,3	29,1	68,1	19,3
12		14,2	19,3	68,1	10,7
13			13,7	68,1	6,0
14			10,5	68,1	
15				68,1	
16				68,1	
17				68,1	
18				68,1	
19				31,4	

Table 4 Results given project data and assumptions

Project	Tax rate	IRR	NPV	% share	Investment	Project (0,1)
1	75 %	39 %	11,2	20 %	70,1	1
2	75 %	35 %	17,7	20 %	154,4	1
3	75 %	15 %	6,2	20 %	176,4	1
4	75 %	17 %	16,1	20 %	196,5	1
5	75 %	22 %	9,8	20 %	101,7	1
6	40 %	39 %	67,5	50 %	175,2	1
7	40 %	35 %	106,2	50 %	386,0	1
8	40 %	15 %	37,3	50 %	441,0	1
9	40 %	17 %	96,5	50 %	491,2	1
10	40 %	22 %	58,9	50 %	254,3	1

Table 5 Capital Constraint

Project	Tax rate	IRR	NPV	% share	Investment	Project (0,1)
1	75 %	39 %	11,2	20 %	70,1	1
2	75 %	35 %	17,7	20 %	154,4	0
3	75 %	15 %	6,2	20 %	176,4	0
4	75 %	17 %	16,1	20 %	196,5	0
5	75 %	22 %	9,8	20 %	101,7	0
6	40 %	39 %	67,5	50 %	175,2	1
7	40 %	35 %	106,2	50 %	386,0	1
8	40 %	15 %	37,3	50 %	441,0	0
9	40 %	17 %	96,5	50 %	491,2	1
10	40 %	22 %	58,9	50 %	254,3	1

Table 6 Organizational Constraint

Project	Tax rate	IRR	NPV	% share	Investment	Project (0,1)
1	75 %	39 %	11,2	20 %	70,1	0
2	75 %	35 %	17,7	20 %	154,4	1
3	75 %	15 %	6,2	20 %	176,4	0
4	75 %	17 %	16,1	20 %	196,5	1
5	75 %	22 %	9,8	20 %	101,7	0
6	40 %	39 %	67,5	50 %	175,2	1
7	40 %	35 %	106,2	50 %	386,0	1
8	40 %	15 %	37,3	50 %	441,0	1
9	40 %	17 %	96,5	50 %	491,2	1
10	40 %	22 %	58,9	50 %	254,3	1

Table 7 Company costs (Not recoverable)

Project	Tax rate	IRR	NPV	% share	Investment	Project (0,1)
1	75 %	4 %	-3,0	20 %	70,1	0
2	75 %	12 %	2,1	20 %	154,4	*
3	75 %	3 %	-10,5	20 %	176,4	0
4	75 %	9 %	-2,6	20 %	196,5	0
5	75 %	4 %	-6,4	20 %	101,7	0
6	40 %	31 %	53,2	50 %	175,2	1
7	40 %	29 %	90,6	50 %	386,0	1
8	40 %	12 %	20,5	50 %	441,0	1
9	40 %	15 %	77,8	50 %	491,2	1
10	40 %	18 %	42,7	50 %	254,3	1

Table 8 Company Cost (Tax recovery)

Project	Tax rate	IRR	NPV	% share	Investment	Project (0,1)
1	75 %	8 %	-1,3	20 %	70,1	0
2	75 %	14 %	4,0	20 %	154,4	*
3	75 %	4 %	-8,4	20 %	176,4	0
4	75 %	10 %	-0,3	20 %	196,5	0
5	75 %	6 %	-4,4	20 %	101,7	0
6	40 %	24 %	37,5	50 %	175,2	1
7	40 %	24 %	73,4	50 %	386,0	1
8	40 %	10 %	0,5	50 %	441,0	1
9	40 %	14 %	57,2	50 %	491,2	1
10	40 %	14 %	24,9	50 %	254,3	1