

**Working Paper No. 55/01**  
**Optimal Petroleum Taxation**  
**Subject to Mobility and**  
**Information Constraints**

by

**Petter Osmundsen**

SNF-project No. 7220:  
«Gassmarkeder, menneskelig kapital og selskapsstrategier»

The project is financed by: The Research Council of Norway

FOUNDATION FOR RESEARCH IN ECONOMIC AND BUSINESS ADMINISTRATION

BERGEN, OCTOBER 2001

ISSN 0803-4028

© Dette eksemplar er fremstilt etter avtale  
med KOPINOR, Stenergate 1, 0050 Oslo.  
Ytterligere eksemplarfremstilling uten avtale  
og i strid med åndsverkloven er straffbart  
og kan medføre erstatningsansvar.

# **Optimal Petroleum Taxation Subject to Mobility and Information Constraints\***

by

Petter Osmundsen

*Stavanger University College / Foundation for Research in Economics and Business Administration*

July 2001

## **Abstract**

Two recent noticeable international developments in the petroleum industry have been mergers and acquisitions, and the opening of new oil producing provinces for transnational oil companies. Both factors contribute to sharpening the international competition between various petroleum provinces in attracting the most competent companies. In addition, we have experienced that the transnational companies have changed their strategies. To an increasing extent they seem to choose a focusing strategy. Many functions are outsourced and one tries to concentrate the activity to a limited number of core countries, and even particular geological structures within the individual countries. The article discusses the implications of the new setting for optimal tax and regulatory design.

---

\* I am grateful to Magne Emhjellen and Morten Halleraker for useful comments and suggestions. I am also thankful for constructive suggestions made at presentations for representatives from The Norwegian Oil Industry Association, The Norwegian Oil Directorate, The Norwegian Oil Taxation Office and The Ministry of Finance. Financial support from Norwegian Research Council is appreciated.

Address of correspondence: Petter Osmundsen, Stavanger University College, Section of Petroleum Economics, Post Box 2557 Ullandhaug, 4091 Stavanger, Norway. Email: [Petter.Osmundsen@tn.his.no](mailto:Petter.Osmundsen@tn.his.no)  
Tel: 47 51 83 15 68. <http://www.snf.no/Ansatt/Osmundsen.htm>

## 1. Introduction

In most economic problems, decision makers are subject to constraints that constrain the opportunity set. This is also the case when a Government wants to design an optimal tax system for the petroleum sector, to promote that high net values are created and to capture a high fraction of the resource rent to the benefit of the population in terms of public services or general tax cuts. The Government is faced with participation and incentive constraints.

The participation constraints impose defined restrictions on taxation, licensing policy and regulation. The framework conditions must be sufficiently favourable for the companies to want to direct their efforts and expertise to the Norwegian continental shelf. In traditional resource economics, one often disregards the participation constraints. This may be a convenient rough approach if fields that are offered are highly prospective. It may also be an approach for fields in operation, as these make up an immobile foundation for taxation. For existing fields, the challenge is to conduct a consistent tax policy in accordance with the expectations the companies were given at the point the investments were made, in order to establish credibility concerning taxation. Tax design can be perceived as a repetitive game between governments and oil companies. Governments rely on the same group of companies to undertake future field developments, and current tax policy is a vital factor in forming the companies' expectations with respect to the future tax regime.<sup>1</sup>

For new fields and for additional investments on existing fields (e.g. in order to prolong the tail phase and increase the rate of recovery), Norway must compete with other oil and gas producing nations to attract competence and resources. This is partly an issue of the quantity of inputs we can attract and - since human resources are heterogenous - partly an issue of quality. Tax competition is also present in industries that exploit non-mobile natural resources, since the input factors and the companies are mobile<sup>2</sup>. 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.<sup>3</sup> This is likely to make the fiscal terms more important, particularly in countries where the

---

<sup>1</sup> See Osmundsen (1999a).

<sup>2</sup> The companies do not need to move all of the operations physically to be internationally mobile. The transnational oil companies' international activity is to a considerable extent managed from the head office.

<sup>3</sup> For a description of international tax and fiscal competition, see Zodrow and Mieszkowski (1986), Gresik (2000), and Olsen and Osmundsen (2000).

remaining acreage over time must be expected to yield economically marginal fields, i.e. where the resource rent experiences a decreasing trend.

One is thus confronted with participation constraints, and these will, over time, aggravate at falling prospects on the Norwegian continental shelf and improved opportunities in new or newly opened petroleum provinces. Competent companies have the possibility to reap parts of the petroleum rent in other countries, and will therefore demand a relatively high alternative rate of return on their scarce resources. These companies will require a corresponding profit on their activities in Norway. The international mobility of these companies entails that they acquire a mobility rent. The authorities will also lack complete information on the size of the petroleum rent and the behaviour of companies. They are thus faced with information constraints, also denoted as incentive conditions. This limits the authorities' ability to capture the petroleum rent, and the companies also acquire an information rent.<sup>4</sup> The potential for taxation is therefore to be found in the following relation: the petroleum rent less the mobility rent and the information rent. This explains why, in practice, it is impossible to tax one hundred per cent of the petroleum rent, as is often presumed in simple closed-economy resource tax models. With the prospect of falling petroleum rents and an increase in the mobility rent as a consequence of increased earning potential in other countries, the average taxation for new fields on the Norwegian continental shelf is likely to be reduced over time.

However, there are factors that are balancing this picture. Recently, a number of fairly large sized reserves have been discovered on the Norwegian continental shelf. Also, mergers among the largest oil companies might open up for new entrants, which may increase the relative bargaining power of governments in a bargaining game between governments and companies over the resource rent. Seen from the perspective of governments, it may be optimal to reduce entry barriers. Moreover, countries where large new discoveries are made, are likely to impose high taxes to capture a large fraction of the rent. Several of these countries are also associated with political risk. The obvious threat to the oil companies is the imposition of higher taxes or stricter regulation than expected after large irreversible investments have been sunk. In the last year, reports have been made on a tougher regulatory regime in Angola, and tax increases have been announced in the Caspi area.

The challenge for tax designers is to promote the development of new marginal fields and at the same time capture a considerable share of the petroleum rent in previous and future

---

<sup>4</sup> See Osmundsen (1995, 1998).

prospective fields.<sup>5</sup> There are many practical monitoring and incentive obstacles to implementation of such tax differentiation.

The concept of neutrality will be different in an open as opposed to a closed economy. In a closed economy there is no desire to distort the investment level of domestic companies. True depreciation and domestic alternative cost for capital must therefore be deductible in the tax assessment. The objective of both the company and the authorities will be aligned, as both parties will want the highest national profit possible. In an open economy characterised by transnational companies, such concurrence will not occur, as the authorities will be concerned with the national profit while the company will be concerned with its global profit. In an open economy, the taxation system is neutral if the companies' decisions as to localisation are not distorted. This implies that companies must be able to make tax deductions for the global alternative cost of their scarce resources, given by the profit the resources could have generated in other oil producing countries.

The objective of this article is to describe and clarify the implications of the different constraints in the petroleum industry that both authorities and companies are faced with.

## **2. Mobility and international tax competition**

In what follows below, a description will be given of international tax competition theory. For high-tax nations, it has become an ever-increasing problem that the tax base is increasingly more internationally mobile. This applies especially to the corporate taxation. If conditions related to tax and regulation are not competitive, internationally mobile companies may move their activities to other countries. Competition may arise between various countries in attracting financially strong and competent companies, and this tax competition will typically lead to a pressure on the tax rates causing these to fall. This is dealt with in international taxation theory, see e.g. Zodrow and Mieszkowski (1986), Haaparanta (1996), Gresik (2000), and Olsen and Osmundsen (2000).

When parts of the tax base are internationally mobile, and thereby able to avoid high taxation, this tends to increase the tax pressure on immobile tax bases, e.g. property. Petroleum taxation is an interesting special case, in this regard. On the one hand, the petroleum resources are attached to the locality (immobile) which speaks in favour of these being good tax bases. (However, the tax potential is reduced in line with falling petroleum

---

<sup>5</sup> See Osmundsen (1999b).

rent over time as a result of falling prospectivity, and the petroleum industry will over time come closer to other industries). On the other hand, production requires substantial resources and competence, and these are possessed by transnational oil companies of very high international mobility. Here, we must draw a distinction between new investments and the investments that have already been made.

Petroleum investments already made, are most often irreversible. The lack of mobility will therefore tempt the authorities to increase taxes after the time of the investment to a level beyond the level held out before the irreversible investments were made. This will, however, lead to an upwards adjustment of the companies' anticipated future level of tax, involve political risk and serve to substantially reduce the incentives to invest in new fields; see Osmundsen (1996). The optimal solution for the authorities is therefore to pursue a credible, predictable and time-consistent tax policy, which for existing fields will mean carrying forth the level of tax that was held out to the companies at the time of the investment.

Mobility may also play a practical role for existing production facilities, in the choice of the level of injection activity, scope of modifications and additional investments, the will to tie in smaller fields, and regarding the time of shutdown. A common feature of these projects - additional investments and extra efforts in the tail-end phase - is that they represent marginal projects. Problems may here arise in that the companies' level of activity is lower (the rate of recovery gets lower) than what is preferable to the authorities. The reason for this discrepancy between business-economic and socio-economic profitability is, in part, that the companies are operating with a higher required rate of return and higher opportunity costs on other scarce inputs than the authorities and, in part, the companies' materiality requirement. Resource management considerations would therefore indicate that the authorities should, over time, improve the companies' incentives in IOR projects and development of marginal fields.

As regards investments in new fields, the companies' mobility comes into play in full. The companies will only go through with new investments on the NCS if anticipated, risk-adjusted rate of return is at least as high as for corresponding investments in other producing nations. It is worth noticing, in this regard, that also the so-called Norwegian oil companies, Statoil and Norsk Hydro, have become transnational companies which in their portfolio evaluations of real investments are continuously holding the earning potential in Norway against the earning potential in other countries. In their formulation of the framework conditions for the offshore sector, for new fields (and marginal IOR projects), the authorities are therefore facing a participation constraint, which involves an effective constraint on the tax level.

The participation constraint is modelled in Osmundsen, Hagen and Schjelderup (1998). Let  $N_h(K_1, \dots, K_n)$  denote the net income from the activity in a transnational petroleum company will generate by allocation of the input factor vector  $(K_1, \dots, K_n)$  to the NCS. The input factors may consist of human, technological and financial resources. In order to arrive at the net income, we deduct national costs for the input factors. Somewhat oversimplified, we may for the purpose of our context say that  $N_h(K_1, \dots, K_n)$  corresponds to the petroleum rent in a closed economy. To consider the effect of an open economy with mobile companies, we introduce  $N_f(K_1, \dots, K_n)$ , which stands for net income after source tax given the best alternative placement abroad for the same input factor vector, roughly corresponding to the petroleum rent that an oil company may realise by instead allocating its scarce resources to other producing nations. The effect of an open economy is that the input factors acquire several alternative applications. The companies' span of opportunities is extended, and the alternative payoff on scarce resources increases. Let  $T_h$  and  $T_f$  stand for the tax in Norway and the best alternative extraction country, respectively. The oil company will only allocate its scarce resources to Norway if after-tax rate of return is at least on level with the return the companies could alternatively have by allocating these resources abroad. The participation constraint for the Norwegian Continental Shelf for a given transnational petroleum company is consequently given by the following:

$$(1) \quad N_h(K_1, \dots, K_n) - T_h \geq N_f(K_1, \dots, K_n) - T_f.$$

In a closed economy, the right-hand side of the participation constraint would have been 0. The companies' opportunities for resource rent-generating activities in other countries are, in other words, imposing additional constraints on the Norwegian level of tax if we would like to see the development of new fields. Norway can, in other words, not capture the entire petroleum rent, even if it had perfect information about the companies' profits on the Norwegian Continental Shelf.

Alternative rate of return on the resources,  $N_f(K_1, \dots, K_n) - T_f$ , given by the after-tax petroleum rent the company may realise by instead allocating its scarce resources abroad, can be perceived as the alternative costs for using the input vector  $(K_1, \dots, K_n)$  on the Norwegian Continental Shelf. Only the payoff in Norway, beyond the alternative payoff abroad, can be

taxed by Norway. Payoff in Norway beyond international alternative payoff can be called country-specific rent or localisation rent,  $L_h(K_1, \dots, K_n)$ , given by

$$(2) \quad L_h(K_1, \dots, K_n) = N_h(K_1, \dots, K_n) - (N_f(K_1, \dots, K_n) - T_f)$$

It is the country-specific rent, and thus not the petroleum rent, that constitutes the potential tax base when the companies are mobile (that is to say for new fields or supplementary investments on existing fields). Foreign rate of return possibilities after tax for the company,  $N_f(K_1, \dots, K_n) - T_f$ , involve an efficient restraint on Norwegian taxation opportunities.

If we assume that Norwegian authorities have perfect information about the tax base, they will be able to capture all of the country-specific rent. The participation constraint (1) will accordingly be binding. Solving (1) with respect to  $T_h$  we derive that Norwegian petroleum tax from this company is equal to the country-specific rent:

$$(3) \quad T_h = N_h(K_1, \dots, K_n) - (N_f(K_1, \dots, K_n) - T_f).$$

Equation (3) gives a clear prediction of Norwegian tax revenues for new petroleum fields depending on the development in prospectivity on the Norwegian Continental Shelf,  $N_h(K_1, \dots, K_n)$ , prospectivity abroad,  $N_f(K_1, \dots, K_n)$ , and foreign taxation,  $T_f$ . Relevant features of development are here as follows:

- (I) Norwegian prospectivity is declining over time, with a greater presence of economically marginal fields, i.e.  $N_h(K_1, \dots, K_n)$  is falling.
- (II) The trend in prospectivity abroad,  $N_f(K_1, \dots, K_n)$ , varies from one country to another. Essential new factors are that large-scale discoveries have been made in other producing nations, i.a. on the western coast of Africa and in the Caspian Sea. In addition, the countries of the Middle East have opened up for participation by transnational companies.
- (III) The tax on the producing activity,  $T_f$ , has been substantially reduced in the UK. The situation in other countries is more varied, also involving tax increases.



There are also good news. Relatively large discoveries are still being made on the Norwegian Continental Shelf, and the discovery rate is high. The development of additional reserves may also, in some cases, offer good commerciality by use of existing infrastructure. Norway may also have a strategic interest viewed in relation to the large gas reserves relatively close to the EU nations, and the political risk is relatively low in Norway. A reduction in development costs and the possibilities for re-using existing pipelines improve profitability. Some of the countries in which large-scale discoveries are being made, also have relatively severe taxation and lack essential infrastructure. The contractor contracts offered in the Middle East are reported to have limited upside potential.

All in all, however, there is no way of avoiding the conclusion that prospectivity over time will be falling on the NCS and that new discoveries in other countries and opening up of new countries have increased earning opportunities abroad. The competitiveness of the Norwegian Continental Shelf will, in other words, be weakened over time. The country-specific rent will fall, both as a consequence of falling prospectivity on the Norwegian Continental Shelf and increasing opportunities abroad. In order to succeed in developing new fields in the Norwegian sector, it will therefore be necessary, in due time, to reduce the average taxation for new activity.

Another challenge to authorities in resource taxation is asymmetric information. We will, in actual fact, have asymmetrical information, i.e. the fact that the company will have better knowledge about its incomes and costs than the authorities, especially as regards the income opportunities in other countries. The companies will hence acquire an information rent, i.e. taxes paid will be lower than the country-specific rent. For a general discussion of information constraints and information rent, see Laffont and Tirole (1993) and Salanié (1998). Due to complex technology and a large number of intra-group and transnational economic transactions, information problems are particularly challenging in the petroleum industry, see Osmundsen (1995, 1998). There are thus two reasons why taxation of the petroleum rent ends up incomplete: (1) the participation constraint associated with internationally mobile companies, and (2) information problems complicating a perfect rent capture. In earlier resource taxation theory, one did not pay consideration to these two constraints, and was therefore unable to explain why one, in practise, never observes complete rent capture (a hundred per cent corporate income tax).

In the presentation above, a number of simplifications have been made. First, the model is static. The net incomes and tax payments above, however, can be conceived of as present values. We have also left out effective resource constraints, such as e.g. the

circumstance that the development activity may be constrained by the availability of core personnel. We have, moreover, ignored fixed area-dependent costs. Resource constraints and fixed area-dependent costs may cause the companies to pose demands on minimum level of present value after tax for new projects, often referred to as materiality, critical mass, or financial volume, see Osmudsen, Emhjellen and Halleraker (2000).

### **3. Neutrality concept in an open economy**

Osmudsen, Hagen and Schjelderup (1998) emphasise that one has to employ a different neutrality concept in an open than in a closed economy. They are describing the recent years' tax reforms which have assumed tax neutrality between different industries (including depreciation that reflects true depreciation) in order to secure equal marginal payoff in different industries in order to maximise the total profit before tax. The authors are arguing that this is based on theories developed under the assumption of a closed economy, and that adjustments need to be made in order to capture internationally mobile companies:

"The conventional line of reasoning is however based on two important assumptions. First, the desirability of a neutral corporate income tax was analysed within a closed economy setting.<sup>6</sup> In an open economy context, tax neutrality would have to mean that the taxation of investment returns does not distort the location of mobile capital. Second, the tax authorities were taken to have complete information about the private and social profitability of firms' investment. As pointed out by among others Boadway and Bruce (1992), in an open economy the corporate income tax will in practice come close to a source tax on investment returns. With returns on mobile investments taxed at source the national government can tax away only domestic investment returns in excess of opportunity returns abroad net of mobility costs."

If the authorities are motivated by revenue considerations, the optimal tax base is, according to the authors, given by the country-specific profit, i.e. the companies are to be allowed deduction of both true depreciation and alternative payoff abroad on scarce factors. The latter means more generous depreciation arrangements for companies that have profitable business

---

<sup>6</sup> See for instance the influential study by King and Fullerton (1984).

opportunities in other countries. This also corresponds with the practise pursued in many countries. The implementation of tax neutrality, in other words, has different properties in connection with internationally mobile companies than for a closed economy.

Osmundsen, Hagen and Schjelderup (1998) deduce optimal depreciation for an internationally mobile industry, which implements the tax model. Total capital deductions,  $D(K)$ , are given by

$$(4) \quad D(K) = \partial K + rK + (N_f(K_1, \dots, K_n) - T_f).$$

The first part of the capital deduction is compensation for value deterioration of the invested capital (depreciation). The second part is the alternative cost of capital in a closed economy, which in turn consists of interest expenses and alternative costs of equity. The latter will have a risk increment as compensation for systematic risk. In an open economy with mobile resources, neutrality will require taxation not to distort transnational companies' localisation and investment pattern.

Investment opportunities abroad mean that the home country can only tax payoff beyond the alternative payoff abroad, i.e. the companies must be offered capital deduction for extraordinary payoff opportunities in other countries, excluding foreign source tax. This deduction is given by the third part/factor of (4). By giving the companies this sort of deduction - i.e. by letting the tax base be equal to the country-specific rent - they will have incentives to maximise the home country's taxation potential. In the above reasoning, the authorities have been assumed to solely be interested in maximising tax revenues from the industry. If the government also assigns a positive welfare weight to the domestic profits in the industry, one will wish to turn investments in the favour of the home country, which will mean more favourable capital deduction than (4).

It will be interesting to compare (4) with the capital deduction recommended by the Norwegian Petroleum Tax Commission, Government Report NOU 2000:18. The last factor in (4) is not included in the Commission's recommendations, the reason being that the Commission implicitly assumes the petroleum industry is part of a closed mainland economy. The implication of the comparison is that the Commission is proposing too weak incentives for investments. The level of investments and tax revenues will thus end up lower than what is optimal from a socio-economic point of view.

In regulating the petroleum industry, Olsen and Osmundsen (1998) argue that the Norwegian government faces two basic types of tax competition (tax is here widely defined as all economic conditions and regulations that affect the localisation decisions of petroleum companies). First, there is strategic tax competition between similar extraction countries, e.g. Norway, UK and Denmark, in which the national governments try to attract investments and human resources from competent companies. Second, the firms may have localisation options outside its present region, e.g. in emerging extraction countries. Recent empirical research show that effective tax rates are important factors for determining the localisation decisions of multinational enterprises.<sup>7</sup> The particular setting of the model is as follows. We focus on multiple-principal regulation of multinational petroleum companies. The firm (the agent) divides its real investment portfolio and scarce human capital between two jurisdictions, and has an option of redirecting parts of its resources from one of the jurisdictions to the other. The firm has an additional option of investing in another region.

The relevant framework of analysis is strategic tax competition, i.e. in designing petroleum taxes the Norwegian government has to take into account that Norwegian petroleum taxes may affect petroleum tax design in other extraction countries. In tax design, a small country assumption is often made, thus ignoring strategic interaction. This approach may be valid for several Norwegian industries; Norway is indeed a small country. But we are a large country in terms of the petroleum industry, and strategic considerations have to be considered in designing taxes.

#### **4. Behavioural assumptions**

Tax design can be perceived as a Stackelberg game. The government has the first move, designing a tax and regulatory regime. Thereafter, the oil companies make their moves, e.g. decide on the amounts to invest on the Norwegian continental shelf. The first mover - the Stackelberg leader - must in its optimisation problem try to figure out the optimal response functions of the followers, i.e. the government needs a model for the companies' actual investment behaviour.

An adequate model of corporate behaviour is also of vital importance for the formulation of a neutral taxation system. If one applies behavioural hypotheses that are not in

---

<sup>7</sup> See, e.g. Devereux and Freeman (1995)).

accordance with the companies' actual behaviour, the tax system will generate unwanted tax-induced distortions.

A recent investigation into oil companies' project valuation practise found that the standard discounted cashflow method was the method most in use by petroleum companies for investment evaluations (Siew, 2001). For practical reasons the oil companies apply an average rate of return requirement for large development projects.<sup>8</sup> The decision making systems must be understood throughout the organisation, be used consistently, and practised in a decentralised manner. These concerns are in favour of a simple system that does not involve too much local assessment. The potential gains of more advanced decision and management systems are also often limited by the access of data.<sup>9</sup>

Recently the issue of distinct required rates of return when discounting individual cashflow streams of oil projects has been raised by the Petroleum Tax Commission. They implicitly propose that the Oil Companies should change their valuation method from discounting the aggregate net cashflow stream to a method where each cashflow is valued separately (NOU 2000:18). Partial cash flow discounting represents an active research agenda, see e.g. Laughton and Jacoby (1993) Laughton (1998a, 1998b), Emhjellen (1999), and Emhjellen and Osmundsen (2001). The same applies to real option theory, see e.g. Dixit and Pindyck (1994). It is therefore interesting and challenging to study optimal tax design subject to different behavioural assumptions. Since existing tax theory rests on the traditional NPV-assumption (average discount rates), there is no consensus on optimal tax design under alternative behavioural assumptions. The Petroleum tax Commission only separates the cash flow of tax reductions due to tax depreciation. They do not discuss the issue of optimal tax design in the case that companies were to implement a full-fledged partial cash flow valuation approach.

Such research can be put to practical use in future tax design if the majority of the companies choose to adhere to new types of investment valuation models. Using it in current tax design analysis, however, is premature, since these type of analyses are in fact not yet widely used. As reported by Siew (2001), the minority of companies that actually use new investment decision models do also not use them in isolation, but rather as a supplement to the traditional NPV method.

---

<sup>8</sup> However, for projects with regulated return, e.g. pipelines, some companies use a partial cash flow valuation approach.

<sup>9</sup> For a discussion of implementation challenges with NCS-data, see Emhjellen and Osmundsen (2001).

The current view in the industry seems to be that it is an open question whether the precision is so accurate in the calculation of the “correct” rate of return requirements for partial cash flow discounting that it is worth the effort of the calculations. The economic analysis departments of the oil companies prioritise the use of their limited resources. A common understanding is that the main challenges in terms of analysis are connected to structuring of the decision tree and a quantification of cash flows to find anticipated value, rather than to develop the risk premium for systematic risk exactly correct.

## **5. Focusing strategies**

To an increasing extent, transnational oil companies seem to choose a focusing strategy. Many functions are outsourced and one tries to concentrate the activity to a limited number of core countries, and even particular geological structures within the individual countries. The reasoning is that companies will become more competitive if they focus on particular core activities and core countries where they have a comparative advantage. One cannot excel at everything. Focusing on few areas also reduces monitoring and administrative costs. In countries where the companies allocate their limited competence and personnel, they want to have a considerable activity and a significant after tax present value, often denoted materiality or financial volume.

A focusing strategy, however, may to some extent be in conflict with risk spreading. By being active in many countries and areas, a company reduce idiosyncratic risk like technical or political risk. By instead investing heavily in a few countries, on the other hand, the company will be vulnerable to different types of country specific risk. Portfolio theory prescribes that idiosyncratic risk will be drastically reduced if a firm invests in six or seven uncorrelated projects of about the same size. Thus, for the large transnational oil companies, being present in a large number of projects around the world, additional risk spreading is not an issue. For small and medium sized oil companies, however, disproportional investments in a few project or countries might be problematic.

Structural rationalisation in the petroleum industry and an increased focus on materiality is not considered in traditional tax theory. The Petroleum Tax Commission, e.g., has made the conventional but unrealistic assumption that companies will realise any project with a positive present value, no matter the size, and that volume bears no significance for the behaviour of the companies.

The conventional models of investment view capital as the primary shortage factor, and the internal rate of return thus becomes the relevant criterion of decision. In designed examples based on internal rates of return, several simplifications and unreasonable assumptions are being made. However, one seems to disregard that there are other shortage factors, one assumes that all relevant costs are included in the project calculations and that the projects are divisible. In reality, there are a limited number of large projects and many shortage factors and bottlenecks. One shortage factors are competent experts, i.e. human capital. For example, there are only a limited number of people who have the necessary skills and experience to manage the complex development projects in the North Sea. Furthermore, there is a shortage of competent geologists and geophysicists. Management capacity is also a shortage factor. The companies will thus consider the rate of profitability (present value) they may get back in relation to the contribution of competence and management capacity. The present value is then compared to the present value one would have received if the restricted resources had been invested in projects in other petroleum provinces where one would retain a greater portion of the valued added. Decisions about investments in transnational petroleum companies will thus consist of a ranking of many projects which show a positive present value, of which only a few will be realised. Other well known reasons for not developing all reserves with a positive NPV is that the partial project calculations do not account for all overhead costs, or that the NPV must exceed the value of the option to wait (irreversible investments).

Present value per shortage factor is not the only focus of the oil companies when they choose where to act. In addition to the evident points concerning prospectivity, cost level, tax level and access to acreage, they focus on getting a maximum of activity and creation of value added (large fields and parts) to carry the considerable fixed costs related to operating in the area, and not least to have a competitive understanding of the underground. The least profitable activity – critical mass – may thus be considerable. Furthermore, most companies experience that a simple structure with a management focus on a few factors is important. Areas that per se are profitable, but that do not create a lot of value added may therefore be abandoned so that management and experts are able to focus on the areas creating value added for the company.

The impact of tax design on a transnational oil company's real investment portfolio decisions is shown in Osmundsen, Emhjellen and Halleraker (2001). They undertake portfolio analysis of an oil company, using real project data. The analysis clearly shows that extraction countries - if they believe that the oil companies will stick to their focusing strategies - need

to curtail the tax system to the resource prospectivity. Less profitable fields call for more lenient taxation (lower average tax rates) for the country to maintain its competitiveness in attracting the most competent and internationally mobile oil companies.

Other factors influencing materiality, both at project and basin level, are the scope and prospect of exploration acreage, 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 often hold a limited equity share in the license. Other companies' equity shares and the Norwegian State's 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 or if there is perfect loss offset. Taxation does thus not reduce the rentability 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 partial 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, if the sale is done on a larger scale. A change in the licensing policies, involving larger equity shares for the privately run companies in new licenses, 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 (specific investments). 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 may have to trade off price (demand for financial volume) against quality (e.g. resource extraction rate). With a system of high marginal tax rates the State also carries a large share of new entrants' learning costs. 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.

## **6. Conclusion**

Petroleum extraction companies are facing stricter participation constraints due to three developments in the petroleum industry: 1) mergers and acquisitions have drastically reduced the number of integrated oil companies, 2) large discoveries in emerging extraction countries, and opening of extraction countries that were previously closed for transnational oil companies, have increased the outside options, and 3) the oil companies are to a larger extent pursuing focusing strategies with emphasis on materiality conditions (financial volume).

The implications of these trends are that licensing and tax conditions more than previously need to be curtailed to the prospectivity in each extraction country or geological area. In particular, countries moving towards more marginal fields must improve overall framework conditions by increasing equity shares to participants in new licenses, by selling state equity shares, and by reducing average tax rates. On the NCS we have seen an improvement in framework conditions, in particular with respect to equity shares and state ownership. At the same time discovery rates have improved.

## Literature

Devereux, M.P., and H. Freeman, 1995, The Impact of Tax on Foreign Direct Investment: Empirical Evidence and the Implications for Tax Integration Schemes, *International Tax and Public Finance* 2, 85-106.

Dixit, A.K. and R.S. Pindyck (1994), *Investment under Uncertainty*, Princeton University Press.

Emhjellen, M. (1999), "Valuation of Oil-Projects Using the Discounted Cashflow Method", *Doctor of Philosophy Thesis at the University of New South Wales*, March 1999.

Emhjellen, K. and P. Osmundsen (2001), "Separate cash Flow Evaluations - Applications to Investment Decisions and Tax Design", mimeo, Stavanger University College.

Laughton, D. and H. Jacoby (1993), "Reversion, Timing Options, and Long-Term Decision Making", *Financial Management*, Vol. 22, pp. 225-240.

Laughton, D. (1998a), "The Management of Flexibility in the Upstream Petroleum Industry", *The Energy Journal*, Vol. 19, pp. 83-114.

Laughton, D. (1998b), "The Potential for Use of Modern Asset Pricing Methods for Upstream Petroleum Project Evaluation: Concluding Remarks", *The Energy Journal*, Vol. 19, pp. 149-153.

NOU 2000: 18, *Skattlegging av petroleumsvirksomhet (Taxation of the Petroleum Industry)*, Report by the Petroleum Tax Commission, delivered to the Ministry of Finance, 20 June 2000.

Olsen, T. and P. Osmundsen (2000), "Strategic Tax Competition; Implications of National Ownership", forthcoming in *Journal of Public Economics*.

Olsen, T. and P. Osmundsen (1998), "Strategic Tax Competition with Outside Options", *Discussion Paper 2/99*, Norwegian School of Economics and Business Administration.

Osmundsen, P. (1999a), "Risk Sharing and Incentives in Norwegian Petroleum Extraction", *Energy Policy* 27, 549-555.

Osmundsen, P. (1999b), "Effektivitet, Incentiver og Proveny" (Efficiency, Incentives and Revenue), Report for the Norwegian Ministry of Oil and Energy, scientific attachement to the annual government report on the Norwegian oil industry, *Oljemeldingen, St.meld. nr. 39 (1999-2000)*, 9. June 2000.

Osmundsen, P. (1998), "Dynamic taxation of nonrenewable natural resources under asymmetric information about reserves", *Canadian Journal of Economics*, 31,4, 933-951.

Osmundsen, P. (1995), "Taxation of petroleum companies possessing private information", *Resource & Energy Economics*, 17, 357-377.

Osmundsen, P., Emhjellen, K. og M. Halleraker (2001), "Transnational Energy Companies' Investment Allocation Decisions", Conference Proceedings, annual conference for International Association of Energy Economics (IAEE), Houston, 25-27 april, 2001.

Siew, Wei-Hun. 2001. "The investment appraisal techniques used to assess risk in the oil industry" Conference Proceedings, 24<sup>th</sup> IAEE International Conference. April 25-27, 2001.