Neutral company taxation under uncertainty, with some experiences from the petroleum sectors of Norway and Denmark

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1. Introduction

The governments of Norway, in 1999–2000, and Denmark, in 2001, appointed public commissions to propose reforms in the special taxes on extraction of petroleum (crude oil and natural gas) in each country, cf. Lund (2002a). The mandates for both commissions asked for more neutral tax systems. Both countries feared that the investment-related deductions were too generous. This was fairly obvious in Denmark, whereas it was strongly denied by the oil companies in Norway.

A more specific aim set up for the Norwegian commission was to level the playing field between established and new companies operating in the sector. Typically the activity requires high outlays over many years before extraction starts. The typical tax treatment of this is unfavorable if a company for a long period has no tax base in which to deduct these outlays. One method to level the playing field is to ring fence every field or area in this respect: All companies are treated equally unfavourable. The opposite method was eventually chosen in both countries, to allow deduction in other income and/or loss carry-forward with interest. This is closer to the ideal of neutral taxation.

In this paper I have a closer look at some of the issues raised in these commissions. I also present a workable method for analyzing economic effects of taxation which would represent an improvement over the practice so far. A definition and discussion of the concept of neutral taxation and its application in the sector is found in Lund (2000, 2002a).

2. The tax systems

Both countries want to channel a substantial fraction of petroleum profits to the treasury. One justification for this has been that there was never private ownership of the offshore resources. With large potential profits (known as resource rents) this has justified both special taxes or fees and various forms of government participation. The licences to explore and extract have been given out almost for free, so the public revenue must be secured afterwards, if profit materializes. An alternative would be to require up-front payment for licences.

Both countries impose a combination of a standard tax on company profits (a corporate income tax) with a special tax on petroleum profits. There have also been some taxes on gross revenue (often known as royalties), but these have been gradually phased out over time.

The typical corporate income tax creates a wedge between pre-tax and post-tax rate of return which is proportional to the tax rate. This leads to reduced total savings and also investment if the economy is not completely open. Most governments are willing to live with this distortion (although to different extents, i.e., with tax rates that vary between nations), but one may want to aim at having the same wedge in all sectors. This requires depreciation rates in line with actual, economic depreciation. Norway tried to accomplish this in a reform in 1992.

A higher tax rate on profits in one sector will increase the wedge in this sector. If there are no counteracting measures, many projects will still be profitable after tax since there are resource rents. But some projects which would be profitable after tax with the standard tax rate, would not be under the higher tax rate. Perhaps equally important, many resources are likely to be left behind in those areas which are developed, while they would be extracted under the standard tax rate. Likewise, many exploration areas will be left unexplored. The higher tax rate will be an obstacle both to marginal fields and to marginal resources within fields and marginal exploration prospects.

To avoid such distortions the tax base for the tax with the higher rate is redefined. The extra taxation in Norway and Denmark is achieved with a special tax, so that income from the sector with resource rents is subject to the corporate income tax (the same which applies in other sectors) plus the special tax. The special tax is not a standard corporate income tax, but a corporate income tax with an extra deduction. Ideally the special tax should work as follows. The extra deduction should be proportional to investment, and could be given various time distributions, as long as the present value of it, together with depreciation allowances, is the same as under a cash flow tax, cf. Boadway and Bruce (1984).

The effect of such a special tax seen in isolation is that an investment project will be profitable when subject to the tax if and only if it is profitable without the tax. The commissions tried to design tax systems close to this ideal, but the subsequent political decisions have seen some compromises.

The corporate income tax does not have this strong neutrality property. The effect of the ideal special tax on top of the corporate income tax would be to maintain the wedge created by that tax between pre-tax and post-tax rates of return. The special tax would not create additional distortions.

It is crucial to determine the relevant discount rate for the design of such a special tax. Denmark had based her deduction, the kulbrintefradrag, on a much to high discount rate. The intention must have been that only projects with a very high rate of return should be subject to the special tax. The problem is that under reasonable assumptions the deduction had so high present value, in relation to the investment, that investment which was completely unproductive before tax could be seen as profitable after tax. This argument goes through if the company has a high probability of being able to utilize the deduction effectively, with no delay. With delays or a probability that the deduction will never be effective, the subsidy effect is reduced. A test of this theoretical argument is that the special tax, the kulbrinteskatt, should yield no revenue. It did not.

The determination of the relevant discount rate is one of the main problems for design of rent tax systems which rely on deduction schemes which are spread out over time. The Danish kulbrinteskatt is just one extreme example of this problem. Only cash flow taxes avoid the problem completely, and only if the tax value of deductions is being paid out when there is no income in which to deduct them.

Since there is a fairly detailed discussion of the relevant discount rate in Lund (2002a), I shall only give a short summary here. Consider what discount rate to apply for risk free cash flows. The Norwegian commission, in line with advice from the Norwegian Ministry of Finance, adopted the view that the relevant discount rate is the risk free interest rate after taxes. This means the risk free rate multiplied by the factor "one minus the corporate tax rate." The argument is that if the company if free to borrow and lend, this is the rate at which it is indifferent towards moving a cash flow from one year to another. A more elaborate argument involves the discount rate of the owners, but could yield the same conclusion.

The Danish commission, however, based its recommendations on advice from the Danish Ministry of Taxes. In order to be consistent with Danish policy on another occasion, one would need to apply a higher discount rate, namely the risk free rate without any tax correction. The main argument for this is that the marginal shareholder in a typical oil company does not pay taxes at the margin, and is thus only indifferent to moving a cash flow in time if it is earns/pays interest at the pre-tax interest rate. As a member of both commissions, with a preference for the former, Norwegian view, I only accepted the latter under the condition that the commission's report explicitly refers to the need to be consistent with previous Danish policy. I also warned that the possibility to carry deductions forward with interest at the pre-tax rate could be profitable to someone who did not have other possibilities for non-taxed interest earnings. For more on this, see Skatteministeriet (2001), p. 132f.

3. The evaluation of proposed tax reforms

While economic theory of neutral business taxation under uncertainty is fairly well developed, at least with respect to firms with well diversified owners, there are several obstacles to its practical application in the petroleum sector. One is the possible coexistence with other domestic taxes, as mentioned above. Another is various complications due to the international character of the sector. One aspect of this is taxation of the owners which may affect relevant discount rates, as mentioned above. Another aspect is taxation of the same or related companies' activities in other sectors or jurisdictions. If these are taxed at lower rates, this creates incentives for tax motivated transfer pricing or real transfers, cf. Lund (2002b). A third aspect is the existence of treaties against international double taxation, as mentioned in Lund (2002a). Because of all these obstacles, a pure form of neutral taxation can hardly be implemented.

Practical compromises can have effects which are hard to predict. The Danish tax which encouraged even unproductive investment is an extreme example of this. In order to predict effects of a proposed tax system, governments may calculate effects through examples. The Norwegian Ministry of Finance has done this on several occasions, e.g., the petroleum tax reforms of 1980 and 1987. The calculations were presented to the parliament.

Such calculations are easily misleading. The typical calculations (Ot.prp. no. 37 (1979–80), table 6.5, and Ot.prp. no. 3 (1986–87), table 7.3.1) show effects of taxation on a small number of typical investment projects. One has calculated the projects' internal rates of return before tax and after various tax systems.

These calculations are based on some predicted prices and extracted volumes. There is no room for uncertainty, except perhaps in sensitivity analyses. Even if in reality there had been no uncertainty, the calculations are misleading. It should be well known that comparison of internal rates of return does not show what alternatives are the more profitable.

Under uncertainty the method is even less adequate. One should take uncertainty into account in a consistent way. Moreover, the measures of profitability should be based on some theory of valuation under uncertainty. While this requires several assumptions which will be somewhat unrealistic, it is clearly less realistic to disregard uncertainty altogether.

The system which was proposed by the Norwegian commission was designed to be neutral under uncertainty. The oil companies, however, claimed that it would distort investment decisions. They claimed that some projects would be unprofitable after tax, even though they were profitable before tax. This can be shown to hold if one considers present value calculations with a constant discount rate applied to after-tax cash flows.

However, according to standard economic theory the after-tax discount rate under uncertainty should reflect the risk of the after-tax cash flow. When one tax system is replaced by another, one should also adjust the discount rate. In practice this is not the way to analyze profitability, because the discount rate could only be determined correctly from case to case. A theoretical discussion is found in Lund (2003). The error in applying the same discount rate turned out to be particularly critical in the evaluation of the suggested reform, which explicitly aimed at reducing the risk of new companies.

The theoretical discussion does not give complete guidelines for a detailed practical analysis. A workable method for comparison of complicated petroleum tax systems under uncertainty is presented in Lund (1992). Instead of finding market values of tax claims as analytical expressions, this method uses Monte Carlo simulations consistent with option valuation techniques.

An example of this analysis is given in figure 1. The analysis concentrates on uncertainty in only one time series, the yearly price of crude oil. The analysis assumes that an oil company makes a choice between various development solutions for a given oil reservoir. For more details, see Lund (1992).

(FIGURE 1 ABOUT HERE)

The upper curve, indicated by plus signs, shows the net market value of the development project without any taxation. In that case the optimal choice of development solution costs 1.2 billion dollars, on the right-hand edge of the diagram. At this point the curve becomes flat, so that profits cannot exceed this level.

The three other curves show that all these three tax systems distort the investment decision. Curve number three from above, indicated by crosses, is based on a corporate income tax with a rate of 50 percent. The optimal development solution has a cost of about 0.5 billion dollars, which is much less than the pre-tax optimum.

Although the diagram refers to a reform some fifteen years earlier, the issues raised then were still discussed by the two commissions. The intention of both was to design a special tax which would not create additional distortions as compared with the corporate income tax alone. Based on a 50 percent rate for that tax, one can compare with the two tax systems shown by the curve above and below. The curve below, which illustrates "After 1987 tax," clearly shows a much more distortive tax system, while the curve above shows less distortion.

There are several improvements compared with the analyses which were presented by the Ministry of Finance previously:

1. The valuation by the companies of claims to uncertain cash flows is introduced in a way which is consistent with standard economic theory. Uncertainty was previously mostly neglected, but in recent years it has been introduced in an ad hoc manner by using risk adjusted discount rates.
2. The effect of taxation under uncertainty has been analyzed based on a detailed account of imperfect loss offset, i.e., applying the rules for loss carry-forward with different outcomes for each realization of the oil price process. This was previously only analyzed along some expected path(s) of oil prices, which overestimates the values of tax deductions.
3. The behavioral response of oil companies to taxation and to uncertainty has been modeled, although only as one decision, a choice of development scale. This is supposed to highlight the major distortion, including the possibility that no development is started. It is easy to introduce some fixed cost to make this more explicit. In previous analyses the effect on behavior was mostly taken to be development or no development, and the exact criterion for this was not made explicit.

However, several simplifications have been made. It should be possible to refine the method to allow some of these to be removed.

One simplification concerns the kind of uncertainty introduced in the calculations. Not only is uncertainty limited to the process of yearly oil prices, but a particular form of uncertainty has to be chosen. In the example the process chosen is called a geometric Brownian motion with drift. This has its limitations as a realistic description of oil prices, cf., e.g., Lund (1993). One way to handle this problem is to try various assumptions, as a means of sensitivity analysis. It is also possible to introduce uncertainty in other variables.

Another simplification has to do with the oil companies' assumed behavior under uncertainty. In line with most previous analyses of the effect of taxation, it has been assumed that the time profile of extraction is given. The optimal choice of time to close extraction down would more realistically depend on oil prices which materialize. It should be possible to include some ad hoc rule of thumb to make an approximation to optimal behavior.

A third simplification has to do with the financial decisions of the oil companies. It is impossible to deal with this in a theoretically satisfactory way. Instead some rules of thumb were chosen, such as a constant debt-equity ratio. Maybe this can also be improved upon.

One particular feature which has received little attention is the need to model features of the tax system which have so far never been tested in practice. The Monte Carlo simulations to be used here give a higher probability to low outcomes for the oil price than what one actually estimates the probabilities to be, given that the oil price is positively correlated with the consumption possibilities of the economy. This is a purely technical way to correct for systematic risk, an alternative to using a risk adjusted discount rate. This alternative has the same effect as risk adjusted discount rates when the model is linear (e.g., when taxes give full and immediate loss offset), but is an essential improvement over risk adjusted discount rates when the model is non-linear.

Since situations with low oil prices are overrepresented in the Monte Carlo simulation, the workings of the tax systems in such circumstances become very important. Some of these may be difficult to predict, since the circumstances may never have occurred in practice, perhaps not even in the lawmakers' imaginations. If they have a positive probability at all, they should in principle be modeled for these calculations to be carried out.

References

Boadway, R., and N. Bruce (1984), "A general proposition on the design of a neutral business tax," *Journal of Public Economics*, 24, 231–239.

Lund, D. (1992) , "Petroleum taxation under uncertainty: contingent claims analysis with an application to Norway," *Energy Economics,* 14(1), 23–31.

Lund, D. (1993), "The lognormal diffusion is hardly an equilibrium price process for exhaustible resources," *Journal of Environmental Economics and Management*, 25, 235–241.

Lund, D. (2000), "Nøytralitet i petroleumsskattleggingen," (Neutrality in taxation of petroleum,) appendix 1 in *Norges offentlige utredninger* (Norway's public reports) 2000:18, 185–226.

Lund, D. (2002a), "Petroleum tax reform proposals in Norway and Denmark," *Energy Journal*, 23(4), 37–56.

Lund, D. (2002b), "Rent taxation when cost monitoring is imperfect," *Resource and Energy Economics*, 24(3), 211–228.

Lund, D. (2003), "Taxation and systematic risk under decreasing returns to scale," Working paper 2-2003, Department of Economics, Copenhagen Business School, http://ir.lib.cbs.dk/download/ISBN/x656102658.pdf

Ot.prp. no. 37 (1979–80), Om lov om endring i lov av 13. juni 1975 nr. 35 om skattlegging av undersjøiske petroleumsforekomster m.v. (Act on amendments in Act of June 13, 1975, no. 35, relating to the taxation of submarine petroleum resources, etc.), Norwegian Ministry of Finance, Oslo.

Ot.prp. no. 3 (1986–87), Om lov om endring i lov av 13. juni 1975 nr. 35 om skattlegging av undersjøiske petroleumsforekomster m.v. (Act on amendments in Act of June 13, 1975, no. 35, relating to the taxation of submarine petroleum resources, etc.), Norwegian Ministry of Finance, Oslo.

Skatteministeriet (2001) (Danish Ministry of Taxes), *Rapport fra Kulbrintebeskatningsudvalget* (Report from the Commission on Petroleum Taxation), Betænkning nr. 1408, Copenhagen, October.

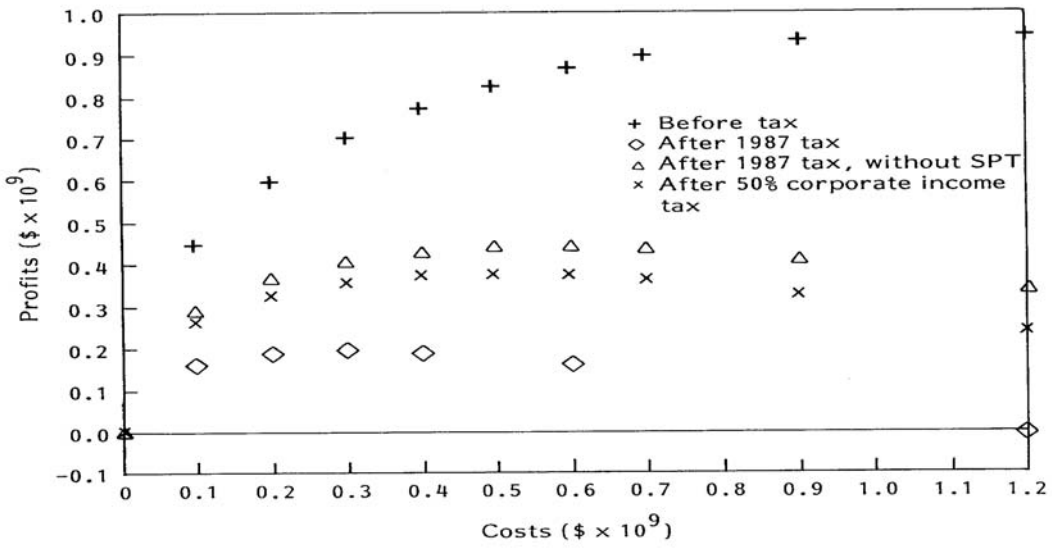

Figure 1: Net market value of investment project as function of net present value of development costs, calculated without taxes and under three different tax systems. Source: Lund (1992).