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On incentives for assurance of petroleum supply

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ABSTRACT

Assurance of supply is a crucial objective for producers and consumers of oil and gas. A basic requirement to meet this objective is that producers and transmitters have sufficient economic incentives and capabilities to assure a desired degree of supply. The topic of this paper is to evaluate these incentives from a broad perspective. We examine economic trade-offs inherent in a delay of production, including reputational issues, as well as contract incentives for gas sellers, drilling companies, and oil service companies.

1. Introduction

Political turmoil, increasing oil price, and the closedown of Gazprom's gas exports to Ukraine in the Winters 2005/2006 and 2008/2009—which also affected the supply to EU countries—have increased the emphasis on production assurance and deliverability in countries that are net importers of natural gas. Gazprom, the largest gas producer in the world, represents 20% of the gas supply to Western Europe, of which 80% is transmitted through Ukraine.

At the same time, maturing OECD petroleum provinces like UK and Norway face partly unexpected production problems, as it has proven more difficult than expected to maintain production from old fields. In addition to reservoir challenges, scarcity of qualified personnel, tailored spare parts, and oil services have been mentioned as explanatory factors. A booming petroleum industry at high oil prices made it hard to recruit qualified personnel and it is hard to get adequate supplies due to scarce capacity in oil service industry.

Apart from political and operational issues, assurance of supply is also closely associated with HSE issues, and is subject to regulations. This is treated in the HSE literature; for an overview, see e.g., [1]. The objective of the present paper is to analyse production performance from an economic perspective. Our experience from the oil industry is that issues of production assurance are often dealt with by engineers at the plant or facility level. They do not often get the attention of top managers. Accordingly, from time to time we see that cost reduction schemes, e.g., cuts in scheduled maintenance, come at the expense of production assurance. These decisions—often taken in periods of decreasing oil prices—are unwise, not only from a technical and an HSE perspective, but also from an economic or purely financial perspective. However, there is a communication challenge—whereas the economic gain of cuts in maintenance is immediate and evident, the downside takes more time to materialise and is more complex. By demonstrating vital and diverse economic effects of production assurance, we hope to contribute to better economic decisions in this field.

Economic decisions on capacity investments, designed redundancy, capacity utilitisation, and maintenance have a significant impact on petroleum extraction and transmission. We evaluate the economic incentives for petroleum suppliers and transmitters to obtain a high level of production performance. As for most economic decision problems—both in investment and operations affecting production and transportation of oil and gas—benefits must be traded against costs. Our focus is on the benefits of production assurance. The cost side seems easier to estimate, at least on a conceptual level (recurring incidents of cost overruns, however, do pose an important practical challenge). Examples are provided from the Norwegian continental shelf, but the challenge of production assurance of petroleum supply applies more generally to the OECD area. According to the International Energy

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Agency (IEA) [2], there has been a sharp decline in petroleum production in the mature OECD area during the mid-2004 to mid-2006 period. OECD total production declined on average by 5% year on year from mid-2004 to mid-2006, exacerbated by extreme weather, unscheduled pipeline and production facility outages, and a lengthening list of new project delays. With cost inflation and shortages of labour, raw materials, and equipment likely to persist, so too will delays and disruptions, according to the IEA.

Our analysis and presentation benefit from conversations and interviews with decision makers and contract managers in the petroleum industry. We also benefit from insights derived from master theses, e.g., Holmefjord [3], where the students address economic issues in petroleum companies. In addition to this empirical material, we base our presentation on current literature on supply chain management, e.g., [4], and on theory of contracts and incentive design, e.g., Milgrom and Roberts [5], Salanié [6], and Olsen and Osmundsen [7]. The present paper is written at a time of a rather low oil price, but our analysis is general and is not affected by this.

The remainder of the paper is outlined as follows. In Section 2 we illustrate economic trade-offs with respect to production assurance in petroleum production, contractual issues are addressed in Section 3, in Section 4 we consider production assurance incentives in the supply chain, production assurance implications of the just-in-time principle are analysed in Section 5, the importance of flexibility in procurement policies are outlined in Section 6, in Section 7 we discuss the issue why production assurance is not high on the agenda, and we conclude in Section 8.

2. Economic trade-offs with respect to production assurance

First a note on terminology. We use production assurance as a term to describe how a system is capable of meeting demand for deliveries or performance [8]. Regularity was a term often used having the same meaning.

To illustrate the economic effect of production loss, we start with summarizing an example from Abrahamsen et al. [9]. As in most industry design issues, the decisions in the case involve balancing of safety versus production performance. Focusing on the economic issues of production assurance, we inquire whether these aspects are adequately accounted for in conventional analytical approaches. We detect several shortcomings.

2.1. An example from the offshore oil and gas industry

We consider the following example in order to illustrate the implications of using expected values. A riser platform is installed bridge connected to a gas production platform. On the riser platform, there are two incoming gas pipelines and one outgoing gas pipeline. The decision problem is whether or not to install a subsea isolation valve (SSIV) on the export pipeline.

The analysis computes an annual frequency of 1×10^{-4} per year for ignited pipeline or riser failures, and an expected number of fatalities without SSIV equal to 5, given pipeline/riser failure, and 0.5 with SSIV installed. The expected damage cost without SSIV is 800 million Norwegian krones (MNOK; 9 NOK=1 euro), given pipeline/riser failure, and 200 MNOK with SSIV installed. When there is no SSIV installed, the riser platform will have to be rebuilt completely, which is considered to take 2 years, during which time there is no gas delivery at all. This corresponds to an expected loss of income of 40,000 MNOK. With SSIV installed, the expected loss of income is 8000 MNOK.

The expected investment cost is taken as 75 MNOK, and the annual expected cost for inspection and maintenance is 2 MNOK. In the calculations of the expected net present value, 10% interest rate is used. This implies that the expected net present value of the valve installation is a cost of 63 MNOK, for a period of 30 years. This gives an expected value of averted fatalities equal to 0.0135. No depreciation of lives is assumed. Thus, the expected net present value of the costs per averted statistical life is 4675 MNOK, and a cursory evaluation of such a value would lead to the conclusion that the cost is in gross disproportion to the benefit. But let us examine the results more closely.

It should be noted that if the frequency of ignited failure is 10 times higher, 10^{-3} per year, the expected net present value of the reduced costs is increased by a factor 10, which implies that the valve actually means an expected cost saving. In this case, the conclusion based on expected values should clearly be to install the valve.

The first observation is that the expected net present value of the reduced costs is strongly dependent on the annual frequency used for pipeline or riser failures. Thus, we need to see the values produced in the risk analysis in view of the assumptions made in the analysis, the limitations of the analyses, etc. We should be careful in making conclusions just based on the calculated numbers. Sensitivity analyses should always be a part of the decision basis provided.

If we return to the base case values, there is a probability of 99.7% (no pipeline or riser failure near the platform, and there is no need for the SSIV) of a 63 MNOK loss (in expected net present value), and a probability of 0.3% of 32 600 MNOK reduced damage cost (also in expected net present value) in a year with a pipeline/riser failure. Hence there is considerable probability of a huge loss.

This analysis, which is representative of the calculations performed in this area in the oil industry, has several shortcomings in terms of economic analyses. First, penalties for omitted gas deliveries – which often are sold on long-term contracts – are not accounted for. Second, postponed production is treated as a permanent production loss, which normally would overstate the costs.

2.2. Economic elements

The economic effect of a temporary shutdown of oil and gas production is given by the expected net present value of the differential cash flow. We calculate the cash flow without a shutdown and the cash flow with a shutdown, find the difference between the two, and calculate the expected net present value, *E*[NPV]. A shutdown immediately reduces the cash flow from a field. Some of the lost production may be recouped at the end of the plateau phase of the field. It may not be recouped immediately after restart of production facilities, as these have limited capacity (e.g., designed for a plateau level of production). Thus, the differential cash flow has an immediate negative element and a positive potential when the field approaches the tail phase. In the case above, the positive element of the differential cash flow is ignored—the lost production is treated as a permanent income loss. This is a common approach. The reason is that it is often a number of years until the potential recouping of lost production, and discounting will decimate the value. But this is perhaps an unwarranted simplification, as significant economic values may be recouped. With a 30-year horizon to the tail phase, the discounted value is only 6%, but with a 10-year horizon, 39% remains, even more so if oil prices are expected to increase. The simplification may still be warranted—if imprecise—if there are additional unaccounted costs of the temporary shutdown.

The differential cash flow is primarily determined by

(a) extra costs related to closing down and opening up production (adjustment costs)