Introduction

On April 1, 1998, John Dolittle received a call he feared would be coming. His client, Linda Sprague, the President of Petroleum Exploration and Production Corporation (PEPCO), wanted to default on PEPCO's contract with John's company, Offshore Drilling Incorporated (ODI). Sprague gave two weeks notice until the papers would be filed.

ODI is an offshore drilling contractor that provides mobile drilling rigs, as well as the expertise and personnel to drill the wells on behalf of exploration and production (E&P) companies. John's client, PEPCO, was one such company. ODI had developed and was operating a rig for PEPCO, and the contract specified that PEPCO would pay ODI a fixed fee, or "day rate" for each day ODI spent on site drilling for oil with the rig.

The day rate specified in the contract between PEPCO and ODI translated into roughly $105,000 per day. When the 39-month contract was first signed, in December of 1995, the price of oil was roughly $19 per barrel, and this left PEPCO with a healthy profit. Since the beginning of December of 1997, however, the spot price of oil had dropped about 20%, from about $19.00 to less than $15.00 per barrel. (See **Exhibit 1**.)

When the price of oil drops below the cost of production, E&P companies typically halt production and exploration, and this was one option that PEPCO was considering. In this case, PEPCO would default on its contract with ODI, and this might lead the two companies into costly and protracted litigation.

An alternative that Sprague proposed to John was for ODI to share some of the losses with PEPCO. The contract would be rewritten so that the day rate PEPCO paid to ODI would be tied to the price of oil.

John knew that the effect of this type of contract would be far reaching for ODI. More than just sharing PEPCO's current losses, the contract would also have effects on ODI's financing. In the longer term, the contract would expose ODI to future fluctuations in the price of oil. Further declines would mean additional reductions in the day rate and additional losses. On the other hand, an increase in the price of oil might actually allow ODI to reap handsome profits.

John also knew that there was the possibility of limiting the risk imposed by a floating day rate. To do so would mean entering into a complex contract with a third party, such as an investment bank or an insurance company, something ODI had never done. It was clear, however, that it was time to explore the possibilities.

Background on Petroleum Exploration and Development

E&P companies search for and develop new sources of oil and gas around the world. The largest E&P companies, such as Shell Exploration and Production and ExxonMobil Exploration, are subsidiaries of large, integrated petroleum companies. PEPCO was a subsidiary of one of these large corporations.

This case was prepared by Noah Gans, Ziv Katalan, and John Young.

Drilling contractors such as ODI provide the equipment, personnel, and expertise required to drill for oil and gas. They typically own and operate their equipment, which consists of on-shore drilling rigs and offshore vessels, such as submersibles, jack-ups, semi-submersibles and drillships. (See **Exhibit 2**.)

A drilling rig's day rate is based on a combination of factors. Operational factors include the rig's specifications, the length of the contract, and the location of wells to be drilled. These drive the cost of the development of the rig, as well as the fixed and variable costs of operation.

Market factors – in particular, the price per barrel of oil – also have a significant, indirect effect on day rates for new contracts. An E&P company's estimate of the market price influences its estimate of the quantity of oil that will be produced as a result of drilling, and this quantity estimate drives the estimated daily cost of operation.

Thus, while the day rate is typically fixed for the life of the contract, without regard to changes in the price of oil or the volume of oil produced, its calculation must account for the fact that changes in market prices may cause the volumes produced to differ from initial estimates. Typically, longer contracts have relatively lower day rates to compensate E&P companies for bearing the risk that oil prices may decline.

Project History and Contract Terms

In this instance, the ODI rig in question, "Drill Deep", was contracted on a fixed day rate basis. However, the project contemplated was somewhat unique in that the wells to be drilled were in very deep water, so Drill Deep needed to be modified to meet these specifications, at a cost of $45,000,000. Because there were no other available rigs capable of carrying out the extensive deep-water drilling program it envisioned, PEPCO was willing to enter into a long term contract with a premium day rate and a special cancellation clause. It had been finalized in the fourth quarter of 1995.

The contract between ODI and PEPCO provided for a day rate of $105,000, about $15,000 higher than somewhat similar units. So far, even given the cost of the upgrade, the contract had been lucrative for ODI. Operating costs excluding debt servicing were about $48,000 per day with some variability based on fuel costs, etc. The upgrade also placed the company in an excellent position to compete in additional deep-water projects being initiated by many of the major oil companies.

The contract's special clause stated that, in the event of cancellation, PEPCO would pay liquidated damages[1] of $45,000,000 to ODI. This guarantee allowed ODI to obtain a loan for the required amount "off balance sheet." That is, the contract itself was used as collateral for the loan, so the loan was then not shown in ODI's financial statements. This off-balance sheet financing was advantageous for ODI, since it maintained the company's capacity to finance other large projects.

[1] Liquidated damages are a contract provision in which one party provides monetary compensation to another should it not fulfill its other obligations under the contract.

In December of 1995 ODI's bank agreed to provide $30,000,000 to help finance the refitting of ODI's rig. The money would be provided in April 1996, before the rig's expected spud date.[2] The loan term was 3 years, and 12 quarterly payments of $2,896,613 would retire the loan at the end of April 1999.[3] The contract allowed ODI to stay well within the maximum loan-to-value[4] ratio ODI believed achievable, which was 60%. ODI had been able to negotiate interest payments of 1-year LIBOR[5] plus 350, approximately 9.7%.

The Current Situation

The price of oil had been dropping precipitously since the beginning of the year. The average of the last 20 days' closing prices was $15.00/bbl for West Texas Intermediate (WTI), the US benchmark. On April 1st the spot price for WTI stood at $15.53 per barrel.

John knew that $15.50 was PEPCO's hurdle rate[6], based on its cost of funds and the infrastructure costs anticipated on this project. At this price, the project had a zero net present value, so PEPCO would not proceed unless costs, such as those associated with the drilling contract, could be lowered.

Either change or cancellation of the contract would be disastrous. ODI could refuse to renegotiate, but obtaining liquidated damages would take time, and in the end the final sum was uncertain. More importantly, ODI would be certain to experience a loss of standing with PEPCO and the other oil companies. If ODI renegotiated, however, then all of the other E&P companies might want to do the same. If a guaranteed contract could be re-negotiated, then the type of contract-based financing that ODI had used to help pay for the $45,000,000 upgrade would no longer be feasible.

ODI needed a way to keep the book value of the contract basically the same, while providing relief to PEPCO. The easiest way would be to have the day rate fluctuate with oil prices. At the same time, by lowering day rates when oil prices were lower, ODI would offer relief to PEPCO.

---

[2] The spud date is the date that a rig breaks ground on a well.

[3] The loan's payments were calculated as a 12-period annuity. Each payment was $30,000,000 x $[r / (1 – 1/(1+r)^n)]$, where n = 12 and r = 2.34% is the quarterly interest rate $[(1+9.7\%)^{0.25} -1]$.

[4] The loan-to-value ratio is a rough measure that is used to estimate a company or project's ability to continue to service its loan obligation in the event its expected cash flow stream changes for the worse. The lower the ratio, the more likely the company will be able to meet its servicing obligations.

[5] LIBOR (The London Interbank Offer Rate) is the cost of funds for banks, and it changes based on the duration of the obligation: 3 months, 6 months, 1 year, etc. Banks often quote loans and other debt obligations in numbers of basis points (increments of .01%) above LIBOR.

[6] Hurdle rate is more commonly used as the name for a company's cost of capital. Many petroleum companies call the price per barrel at which discounted cash flows (discounted at the company's cost of capital) have a zero net present value (NPV) the hurdle rate, however. If the price per barrel of oil drops below the hurdle rate, then the project has a negative NPV. Dolittle believed that, when originally calculated, the $15.50 hurdle rate included a premium for the possibility of liquidated damages.

Sprague had mentioned this during John's conversation. She had even stated that PEPCO would be willing to allow day rates to go higher than $105,000 if the price of oil were to rise, rather than continue falling.

Still, ODI needed predictable, non-volatile income or the company would be penalized because outside parties (banks, equity analysts, etc.) would take a very conservative view of the company's earnings. Volatility would hurt ODI's stock price and its ability to raise funds. A contract with a floating day rate would be likely to create difficulties for ODI with its financing, its revenue projections, and with maintaining its in-force contracts with other clients.

John thought about locking in a stable oil price by buying options or futures contracts in the commodities markets, but he worried that ODI lacked the expertise. He remembered the highly publicized bankruptcy of Metallgesellschaft Refining and Marketing, which in 1993 had lost more than $1.3 billion buying energy futures. In addition to this underlying basis risk, ODI had no experience implementing or managing such a program.

He also anticipated that other E&P companies would want/demand to use any product developed. While the time remaining in ODI's contract with PEPCO was one year, most deep-water contracts last more than 3 years. The lack of volume and liquidity of long-term contracts would make this type of hedging program difficult to implement for other clients.

If he could find a hold-to-maturity[7] counter party, then he might be able to hedge without using the futures market. He thought an insurance company might be the answer.

A Possible Solution

John approached a progressive insurance company, International Insurance, and told them his problem, and in an initial meeting, Jurg Meissner, a specialist at International Insurance, and John developed the outline of a program that would allow ODI to limit its market risk:

1. At the start of the program, ODI, PEPCO, and International Insurance would agree on a target price per barrel, most likely $15.50. At this target, the day rate would be $105,000.

2. The average price of oil would be calculated once a quarter and would be based on the average of the previous 13 Fridays' closing prices for WTI crude.

3. For each $1 change in the average price of oil away from the original target, the day rate paid by PEPCO to ODI would change by $10,000. This day rate would be in effect for the previous 91 days (13 weeks, 7 days per week), the time period over which the average was calculated. In the rare event that the average price were to drop below $6.00 (by more than $9.50 below the $15.50 target), then PEPCO would continue to pay ODI a day rate of $10,000. For example, a $0.50 change in the

[7] A hold-to-maturity counter party would "buy" the risk induced by uncertainty of the future price of oil directly from ODI without requiring that the investment be liquid. That is, the buyer would hold the risk until it expired and not consider reselling the risk to another party.

average price over the quarter would cause the total of the day rates to change by $455,000 (91 x ($0.5/$1.00) x $10,000) over the same period.

4. Each $1 the average price fell ***below*** the original target price would the basis for a claim that International Insurance would pay to ODI as well. Again, if for example the average price over the quarter fell $0.50 below the target of $15.50, then the claim of $455,000 (91 x ($0.50/$1.00) x $10,000) would be paid.

5. The contract would last for four quarters, until the end of the term of ODI's and PEPCO's original agreement.

6. The premiums ODI would pay International Insurance would be based on the expected present value of the claims International Insurance was to pay ODI. It would also include a "markup" that would represent International Insurance's expected profit on the deal. The present value and markup would be split among four quarterly payments.

(**Exhibit 3** provides an example of the payout calculations. The example assumes that the present value of the premiums, plus markup, equals $400,000.)

Both John and Jurg were excited about the possibilities of completing what would be a landmark transaction. There was still significant work to be done, however. John would set up a round of meetings with Linda Sprague and PEPCO to solidify the terms of the floating day rate, and Meissner would work with the market specialists at International Insurance to ensure that the program could be underwritten.

John went back to Linda Sprague and outlined the structure of the program that he and Meissner had developed. Sprague agreed to the overall scheme without hesitation. How much each of the two parties would be willing to pay to buy the insurance remained an open question, however.

John knew that PEPCO was at a negotiating advantage: PEPCO and its parent were large enough within the industry that they could afford to break the contract and enter litigation concerning liquidated damages, while ODI could not. At the same time, John was confident that going to court would also hurt PEPCO and was not an appealing prospect for Sprague.

Underwriting Difficulties

Ultimately, how much each of the firms would be willing to pay would depend on the cost of the insurance provided, and this had yet to be determined. Several days later John met again with Jurg Meissner and a team from International Insurance to flesh out the contract specifics.

In this meeting, John learned that International Insurance was hesitant to underwrite the insurance program as it was originally structured. Meissner explained that follow-up work he had done with the underwriting and capital markets groups at International Insurance had identified two elements of the contract as problematic.

First was the fact that ODI wanted to make claims on a quarterly basis. The underwriting group believed that this subjected International Insurance to too great a risk from truly short-term fluctuations in the price of oil. The underwriting group had suggested two alternatives that would reduce the exposure to these short-term fluctuations and, at the same time, protect ODI against a year-long downward drift in the price of crude oil:

- Option one was simply to write the contract with one claim, made at the end of the year, that would be based on the previous 52 Fridays' closing prices.

- Option two was to reset the target price at the end of each quarter. That is, at the end of the first quarter, the payout from Insurance International to ODI would occur as originally envisioned. Each of the *next quarters'* target prices would then be the average price calculated from the previous 13 Fridays.

Second was the fact that ODI wanted to base the program on the spot price of WTI. International Insurance's own expertise and operational strengths were in the European markets, and the company believed it would be more likely to find a counter party if the grade of oil were Arab Light or North Sea Brent. For this reason International Insurance preferred to write the contract based on the spot prices of these types.

After laying out these alternatives, Meissner was careful to emphasize that International Insurance was ready to help ODI whatever its needs were. International was willing and capable of underwriting the original program, as discussed at the first meeting. If, however, ODI believed that any of the alternatives presented would meet its needs, then International could underwrite them at a lower cost.

Meissner did not give specific information as to what the costs would be. Dolittle realized that, at this point, his own team at ODI needed to develop its own picture of what the various options would be worth to ODI.

Analyzing the Options

John Dolittle returned to ODI's Houston headquarters and set up a team to come up with a negotiating strategy. He commandeered a conference room and turned it into a "strategy" room.

John described the situation to the team, and all agreed that an effective negotiating strategy required good estimates of the values of the various contract proposals. He described the scenarios that needed to be evaluated.

First would be two base cases: one in which the current, fixed day rate was maintained until the end of the April 1999; and another in which ODI and PEPCO entered into a floating day rate but no insurance was bought. These base cases would act as benchmarks against which the performance of the other schemes would be judged.

Then three different insurance contracts needed to be analyzed:

- one in which ODI would make quarterly claims to International Insurance;
- one in which ODI would make a single claim at the end of one year; and

- one in which ODI would make quarterly claims, but the target price each quarter would be reset to be the average price calculated from the previous quarter.

All together, there would be six scenarios that required evaluation, three in which the insurance would be based on the price of WTI, and three in which it would be based on Arab Light. In all six scenarios, the contract between ODI and PEPCO would be based on the price of WTI.

Dolittle pointed out that, in each of these scenarios, two factors would be of the highest importance to evaluate. First would be the overall value of the cash flows. This, of course, would be the primary determinant of what ODI would be willing to pay International Insurance and what it would require from PEPCO as compensation. Second would be the risk of facing any large, negative cash flows along the way. Because of its heavy use of off-balance financing, ODI was highly leveraged, and a large enough accumulation of negative cash flows could drive the company into bankruptcy.

The team decided that it would use Monte Carlo simulation to evaluate the various options. It went to work on developing a suite of simulations that modeled the effect of changes in oil prices for the various contract proposals. As work on the models progressed, it became clear that the biggest problem would be coming up with the "right assumptions" concerning the movements of the price of crude oil.

The team decided to perform a sensitivity analysis. For each scenario, it would run a series of simulations in which it systematically varied key assumptions concerning the price of oil:

- mean annual percentage change in price: -10% to +10%
- standard deviation of the annual percentage change in price: 20% to 60%;

For scenarios in which two grades were used, the team would use the same mean and standard deviation for the spot price of both WTI and Arab Light. In these cases, it would vary the correlation between the returns of WTI and Arab Light between 0.70 and 0.99.

Thus, the plan for how to proceed was clear. The number of simulation runs would be quite large, however.[8] In turn, the synthesis and use of the results in the development of a negotiating strategy would not be an easy task.

[8] The case questions will *not* ask you to perform a complete sensitivity analysis. You will perform a small subset of the possible simulation runs.

Exhibit 1 Price Path of West Texas Intermediate Crude Oil

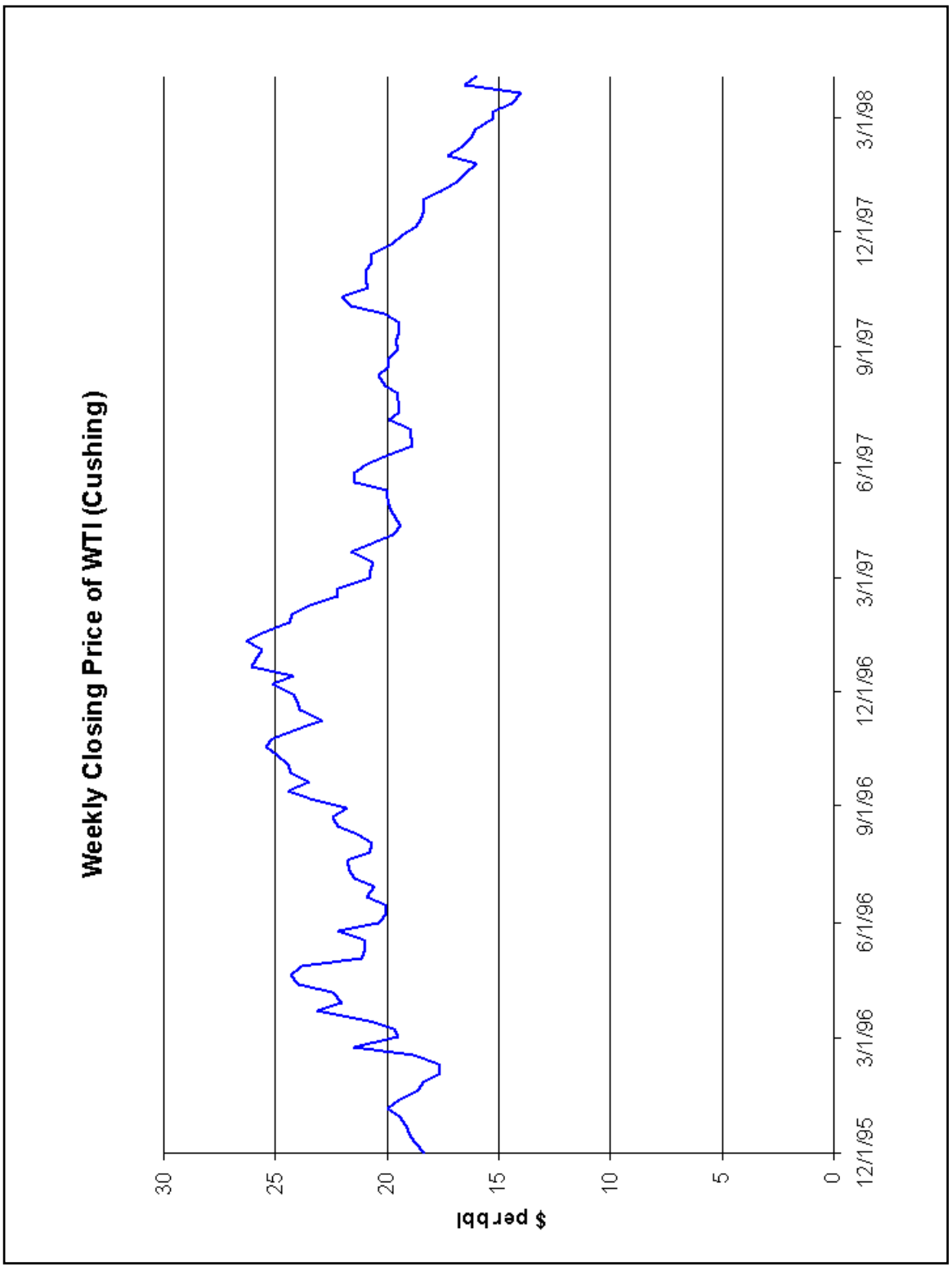

Exhibit 2 Types of Drilling Rigs

A submersible is used in shallow water, usually 80 feet deep or less. It is towed to its location where it is submerged until it sits on the bottom. The rig is moored under its own weight, although anchors may also be used.

Drillships are self-propelled and carry both a ship's crew and a crew of drilling personnel. They are moored either by a standard anchoring system or by dynamic positioning of the vessel. Dynamic positioning is the use of a computer-operated thruster system which keeps the vessel on location without the use of anchors. This arrangement allows vessels to drill in extremely deep water, often more that 6,000 feet deep.

Jack-ups are used in waters up to about 600 feet deep. They are towed to their location and heavy machinery is used to jack the legs down into the water until they are on the ocean floor. When this is completed, the platform containing the work area rises above the water, and the rig is ready to begin drilling.

A semi-submersible has multiple hulls like a catamaran and is either towed or self-propelled. It can be dynamically positioned or it can use anchors. When the rig is on location, it is ballasted down, in the same way a submarine submerges, fifty feet or so to give it stability. Semi-submersibles are heavy-duty rigs that are designed to drill in adverse weather conditions and water thousands of feet deep.

Source: http://offshoreguides.com, http://www.noblecorp.com.

Exhibit 3 Example Cash Flow Calculations for a Contract with International Insurance

Row		Quarter 1	Quarter 2	Quarter 3	Quarter 4
A	**Average Price over 13 Fridays**	14.00	10.00	16.00	15.00
B	**Contract Revenue**	8,190,000	4,550,000	10,010,000	9,100,000
C	**Operating Expenses**	(4,368,000)	(4,368,000)	(4,368,000)	(4,368,000)
D	**Loan payment**	(2,896,613)	(2,896,613)	(2,896,613)	(2,896,613)
E	**Cash flow without Insurance**	925,387	(2,714,613)	2,745,387	1,835,387
F	**Insurance Claim**	1,365,000	5,005,000	-	455,000
G	**Insurance Premium**	(101,258)	(102,532)	(103,821)	(105,127)
H	**Cash flow with insurance**	2,189,129	2,187,855	2,641,566	2,185,260

Notes

A A_i = price calculated from the average of a sample of simulated oil prices over quarter *i*

B Revenues from ODI's contract with PEPCO = max{(105,000 + (A_i - 15.50) * 10,000) , 10,000} * 91

F Revenues from ODI's contract with International Insurance = max{15.50 - A_i , 0} * 10,000 * 91

G Premiums, assuming that the total PV cost of the premium is $400,000. Each quarter's premium is the future value of 1/4 of the total ($100,000) grown at 5% per year (roughly 1.258% per quarter).

Offshore Drilling Incorporated Case Analysis and Report

First, perform the simulation analysis of two base options: PEPCO's proposed floating day rate contract, as well as one of the possible contracts offered by International Insurance (details below). Then use your results as the basis for an evaluation of and recommendations concerning ODI's options. Your report should include the following:

- An interpretation of the simulation results for the two base options and a comparison of the advantages and disadvantages of the two options.
- Proposals regarding any other options that you believe ODI should consider. While there is no requirement that you numerically analyze these additional options, the more explicit your argument concerning why they could be beneficial, the better.
- Final recommendations to ODI. What "next steps" ODI should follow as it negotiates with PEPCO and International Insurance.

Your write-up should be 2-3 pages long and should include a one-paragraph executive summary and a summary of the important simulation results.

An Appendix should include simulation results for each of the three parts, below. For each simulation include a) a frequency histogram, b) percentiles, and c) summary statistics.

Simulation Analysis

Parts 1 to 3, below, ask you to perform a series of analyses that explicitly evaluate how the contract originally proposed by International Insurance mitigates ODI's risks from the floating day rate.

For each simulation model run 10,000 trials. Your simulations may use any seed value you like.

1) Evaluating PEPCO's proposed floating day rate

   First, consider the cash flows that ODI receives from PEPCO without any insurance (the "naked" contract). To do so, download and run the simulation model, **ODI Template.xls**, which we have constructed for you.

   The simulation model captures the evolution of the price of West Texas Intermediate (WTI) crude oil and its effect on the contract between ODI and PEPCO, shown in rows A through E of Exhibit 3 of the case.

   The model assumes that the weekly evolution of the price of WTI oil is *lognormally* distributed,

$$P_{t+1} = P_t e^{(((\mu - 0.5\sigma^2)/52) + (Z\sigma/\sqrt{52}))} \qquad t = 0,\ldots,51 \qquad (1)$$

where μ and σ are the mean and standard deviation of the annual percentage change in the price of oil, *Z* is a "standard Normal" random variable (mean of zero, standard deviation of one), and *t* represents the week number.[9]

The model assumes that the starting spot price of oil and the starting target price are both $15.50 per barrel, that the annual percentage change in the price of oil has a mean of μ = 0.0% and a standard deviation of σ = 40%.

The simulation then calculates two important performance measures for the contract: the present value of the contract and a risk measure which is based on the most negative cash position over the four quarters. More specifically, if CF_i is the cash flow in period *i*, then the present value of the cash flows is

$$PV = CF_1 * e^{-r*13/52} + CF_2 * e^{-r*26/52} + CF_3 * e^{-r*39/52} + CF_4 * e^{-r*52/52} \qquad (2)$$

For simplicity, the simulation uses the risk-free rate of r = 5% per year.

The most negative cash position is calculated in two steps. First

$$CCF_1 = CF_1 \qquad CCF_2 = CF_1 + CF_2\,, \qquad (3a)$$
$$CCF_3 = CF_1 + CF_2 + CF_3 \qquad CCF_4 = CF_1 + CF_2 + CF_3 + CF_4 \qquad (3b)$$

are the cumulative cash flows in each of the four quarters. Then $\min\{CCF_1,...,CCF_4\}$ is the most negative position over the four quarters. This assumes the initial cash position equals zero.

2) Valuing International Insurance's quarterly-payment, fixed-target contract

Next, you should extend the spreadsheet model to construct a simulation for the claims paid by International Insurance to ODI.

You should use the same assumptions concerning the price of oil that were made for part 1. Then calculate the payout from International Insurance to ODI as in line F of Exhibit 3. Given these cash flows, you can calculate the present value of the contract payments in the same way that the present value for the naked contract was calculated in part 1.

3) Evaluating the combined effect of floating day rate and insurance contracts

Now, put the two contracts together and develop a spreadsheet simulation for all of Exhibit 3. Line H of the exhibit shows the net cash flow to ODI each quarter.

To do this, you will need to calculate the premiums paid by ODI to International Insurance, shown in line G of the exhibit. Assume that the price of the insurance is

[9] Recall that the daily return (percentage change) of the price of oil can be modeled as normally distributed. When several days' normally distributed returns are compounded, the overall change in price may be modeled as being *lognormally* distributed, as defined above. For more on this relationship see, for example, John C. Hull, *Options, Futures, and Derivative Securities*, 7th Edition, Prentice-Hall, 2007.

30% more than the expected present value (EPV) of the claims, which you estimated in part 2.

Note that, in line G of Exhibit 3, the premium is paid in 4 quarterly installments. To account for the time value of money, each quarter's payment is adjusted upward by the appropriate risk-free rate:

$$\text{PREM}_i = \frac{\text{EPV} * 1.30}{4} \times e^{r \times (i/4)} \qquad (4)$$

where r=5%.

As in part 1, you should set up your simulation to calculate the present value of cash flow with insurance, shown is line H of Exhibit 3, as well as ODI's most negative cash position over the four quarters.