Selection of Discount Rates for MMS Evaluation of Lease Sale Bids.

William W. Wade, Ph.D.[1]
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Wade@energyandwatereconomics.com

1 MMS Rejected the Second Highest Bid in Lease Sale 185

MMS rejected bids on two ChevronTexaco tracts in Lease Sale 185, March 2003, in the Central Gulf of Mexico (GOM) as less than fair market value (FMV). The Secretary of the Interior is required by law to see that the Government receives a fair return for offshore lease rights granted. To assure that the Government receives a fair return for these leases, the Department uses a two-phased bid evaluation process "for ensuring receipt of fair market value on Outer Continental Shelf (OCS) oil and gas leases."[2] MMS routinely rejects lease sale high bids that do not meet FMV criteria under its bid adequacy procedures.

MMS rejected 16 high bids in Sale 185 totaling $17.9 million as insufficient for FMV.[3] The rejected ChevronTexaco bids, however, were not routinely deficient bids. ChevronTexaco's rejected bid for Green Canyon tract 468 at $7.75 million was a close second to Hunt Petroleum's highest bid in the sale, $8.2 million, for tract South Marsh 109. ChevronTexaco's bid for Green Canyon tract 512, $3.75 million, was the 13th highest bid in the lease sale that brought bids for 561 Leases. These two bids comprised two-thirds of the amount of the rejected $17.9 million bids. As custodian for country's federal energy resources, did MMS perform a valuable service for taxpayers

[1] The author, President of Energy and Water Economics, Columbia TN, wade@energyandwatereconomics.com, has conducted exploration and development evaluations over the last 30 years, both for MMS on offshore development planning projects in the AOCS and deepwater POCS, and for industry in the GOM. Helpful comments are acknowledged from Robert Trout, Ph.D./CFA, Lit-Econ LLP, San Diego, CA; and Michael Elliot-Jones, Ph.D. Bala Research Inc., Santa Rosa, CA. Remaining errors are the author's.

[2] See MMS Bid Adequacy Procedures, 64 Federal Register 132, 37560-37562, July 12, 1999, to ascertain the details of the procedures and bid adequacy criteria.

[3] MMS Press Release, "Central Gulf of Mexico Sale Nets $297,598,165 in High Bids" June 17, 2003.

by rejecting these bids as less then fair market value? Not if the bid adequacy process is biased against tracts with higher risk.

Besides their relatively high dollar value compared to other accepted and rejected high bids, one significant difference distinguishes the bids on the two adjoining GC tracts from the routine: the exploration target analyzed by both ChevronTexaco and MMS is 32,500 feet below mud line (BML) -- ultra deep -- in the deep water Gulf.[4] Two-thirds of the winning bids were in shallow water on the shelf. No operator in the Gulf of Mexico has drilled below 30,000 feet BML. The ultra deep target is a frontier that would test existing technologies and know-how. Only ChevronTexaco has any successful drilling experience near 30,000 feet BML in GOM. Tahiti (GC-640 - 28,411' TD) and Poseidon (MC-727 29,680' TVD) place ChevronTexaco at the frontier of technical knowledge. Not surprisingly, no other bidder submitted serious bids on the tracks.[5]

Under Interior bid adequacy procedures, MMS economists follow a two-phased approach to determine the fair market values for tracts to be leased. Phase 1 includes evaluation criteria for accepting high bids on tracts that attracted three or more qualified bids and determining what other bids will receive further evaluation in Phase 2. For tracts that do not pass Phase I screening criteria, MMS estimates two important values and compares these to submitted winning bids: MROV and DMROV.[6] The MROV is the dollar measure of a tract's expected net present value, if that tract is leased in the current sale. The calculation of the MROV allows for exploration and economic risk, and includes tax consequences; i.e., the calculation relies on after tax results. MMS discounted bids received for all tracts in LS 185 with an 8 percent hurdle rate for evaluation of Gulf of Mexico bid adequacy. The *delayed* MROV (DMROV) is a measure used to determine the size of the high bid needed in the current sale to equalize it with the discounted sum of the bonus and royalties expected in the next sale, less the foregone royalties from the current sale. If the high bid exceeds the DMROV, then the

[4] Telcons with ChevronTexaco officials during September, 2003. Water depth ranges up to 4,000 ft.

[5] Nexen Petroleum Offshore USA submitted bids of $309,000 for GC 468 and $689,000 for GC 512.

[6] Mean Range of Value.

leasing receipts from the current sale are expected to be greater than those from the next sale.

Table 1 shows MMS' MROV values compared to ChevronTexaco's submitted bids for the two tracts. The tract values can be added because the target underlies both tracts. Regardless of the GC 468 bid being the second highest bid in the sale, MMS' estimated DMROV is more than twice the submitted bid. As custodians of the resource, MMS elected to reject the bids and leave the potential hydrocarbon unsold hoping some later bidder comes closer to their estimates. As Peggy Lee might say, "Is that all there is to that?"

Table 1: ChevronTexaco Bids Compared to MMS MROV ($1000)

	ChevronTexaco High Bid	MMS MROV	MMS DMROV
GC 468	$ 7,750	$15,000	$14,000
GC 512	$ 3,754	$17,000	$15,000
Total	$11,504	$32,000	$29,000

Source: MMS, LEASE SALE 185, PHASE 2 DECISION INFORMATION MATRIX, June 16, 2003

Well, no. In exploration evaluations, hundreds of geologic, production rate, cost, timing and price assumptions comprise the calculation of a prospect's MROV. Geologists and engineers can disagree about innumerable assumptions to wonder what variables set these two estimates apart. After all, the target is ultra deep, sub-salt, where even 3-D seismic yields poor results. Apart from geology, cost, timing and price assumptions that determine the potential cash flows for economic evaluation, the single-most important assumption that determines net present value or MROV is treatment of risk within the discount rate MMS uses to evaluate each prospect. MMS evaluated LS 185 tracts for bid adequacy with an 8 percent discount rate applied uniformly across all tracts -- without regard to depth of target BML or depth of water, factors that reasonably can be seen to create differences in risk among the tracts.

This article examines the use of "one size fits all" 8 percent discount rate across lease sale bids to show that it overstates their estimated MROV of relatively higher risk exploration prospects and understates the value of prospects with lower risk. The article

points out the detrimental effects on leasing policy of shortcomings of MMS' discount selection and application methods. MMS did not provide a valuable service for the taxpayers if technical innovation necessary to open the ultra deep drilling frontier and promote needed energy production were delayed because of theoretical and practical shortcomings in its valuation methods.

2 Mathematical Underpinnings Reveal relationship of *ex post* Cost of Equity to Cost of Capital -- Neither of which is the "right" hurdle rate

MMS' choice of 8 percent hurdle rate for evaluation of Gulf of Mexico bid adequacy is linked to published Ibbotson estimates of weighted average cost of capital (WACC). Consider the financial equation for WACC, which MMS relies on to support its choice of discount rate.

[1]

$$WACC_i = (w_{Ei} \times R_{Ei}) + \left[(w_{Di} \times R_{Di}) \times (1 - t_i)\right] + (w_{Pi} \times R_{Pi})$$

Where:

$WACC_i$ = Weighted average cost of capital for company i;

w_{Ei} = Weight of equity capital in company i's capital structure, equal to equity capital, based on capitalized market values, divided by total capital;

R_{Ei} = Cost of equity for company i;

w_{Di} = Weight of debt capital in company i's capital structure, equal to debt capital divided by total capital;

R_{Di} = Cost of debt for company i;

t_i = Marginal tax rate for company i;

w_{Pi} = Weight of preferred stock capital in company i's capital structure, equal to preferred stock capital divided by total capital; and,

R_{Pi} = Cost of preferred stock for company i.

The value of the term R_{Ei} in the WACC equation represents the shareholder's required return for the firm. Equity is the largest share of capital in the typical large oil company. So, this term is the largest determinant of WACC. Cost of equity can be defined more

precisely as the cost of obtaining and retaining capital from investors. R_{Ei}, investors' expected return to the company's stock, is comprised of three important components.

[2] $R_{Ei} = R_f + (R_m - R_f)B_i$

Where:

R_f = risk free long Treasury bond instruments, say ten-year treasuries;
R_m = the expected overall return for a financial market equity portfolio;
R_m-R_f = equity risk premium
B_i = the *beta* coefficient, or measure of variability of returns apart from market risk.

Beta is a measure of the firm's variability of returns apart from the underlying risk of the securities market. So, investors' required rate of return for equity in firm *i* is equal to the return for risk free investments plus a risk premium, which in turn is a function of the underlying market risk less the risk free rate (equity risk premium) and the *beta* coefficient. *Beta,* explicitly, is a measure of the variance of the firm's return apart from the underlying equities market; i. e., *beta* measures firm risk, not the risk of specific elements of the portfolio of activities that comprise the firm -- especially not a frontier exploration risk.

3 Treatment of Risk and Uncertainty in Exploration Economics

Risk and uncertainty dominate exploration economics. Risk and uncertainty may be distinguished by saying that they both refer to future outcomes of which one is unsure, but in the former case this can be quantified, while in the latter case it cannot. Typically, exploration uncertainty is treated in both an explicit decision tree approach to evaluate different project outcomes (probability of discovery versus "dry hole") and in a Monte Carlo simulation that (hopefully) encompasses the range of uncertain annual flows and total hydrocarbon recovery. Remaining risky costs, market conditions, and prices are simulated as well, sampling along some user-specified distribution between the end points.[7] The cash flows on the discovery node of the decision tree are then discounted by a hurdle rate, which -- hopefully -- includes a risk premium that reflects the risky elements bearing upon the investment decision.

[7] Two prominent spreadsheet simulation software packages are Crystal Ball and @Risk, either of which is essential for analyzing exploration prospects.

The MMS MROV definition refers to two generic sources of risk -- exploration and economic. Economic risk means, typically, the risk that the project's output will not generate sufficient revenues to cover operating costs and provide an adequate return to investors. This definition is too vague to illuminate the risks bearing on a frontier ultra deep project like that underlying GC 468 and GC 512. Economic risk can be partitioned into business risk and frontier technology risk to improve clarity. Business risk arises because of the inability of industry decision makers to predict with certainty the prospective cash flow values of developing a discovered petroleum field in the competitive and unstable energy marketplace. All tracts in a lease sale face this risk.

Frontier technology risk arises because of the inability of decision makers to anticipate fully the drilling challenges and costs of ultra deep wells. Although a budget may be assigned for funding exploration of the prospect, it may prove inadequate for a host of reasons.[8] Unforeseen budget overrun and delayed production are the main practical consequences of ultra deep wells.[9]

Investments in projects of a certain risk require an expected return discounted at a certain rate that, at least, equals the opportunity earnings foreclosed from another investment opportunity. Opportunity cost can be called the firm decision makers' expected, indeed required, minimum hurdle rate of return associated with projects of comparable risk. The typical financial analysis discounts cash flows with the appropriate "hurdle rate." The hurdle rate is a decision parameter such that if IRR> hurdle rate, then accept the project; or, if NPV discounted using the hurdle rate > 0, then, accept the

[8] The host of challenges of drilling and completing ultra deep wells is the subject of a different article by scientists and engineers. See Scott McLeod & Frank Hartley, "Drilling Technology: Part 1: Poseidon 29,000-ft. well in 4,800-ft. depths harbinger of future for US Gulf." Offshore, April, 2001; Part II: "Positive and negative events in drilling of Poseidon 29,750-ft. well," Offshore, May, 2001.

[9] This definition is a variation on a definition of innovation risk discussed in Gavin C Reid & Julia A Smith. "Accounting for Risk: developing a new research agenda for risk appraisal in high-technology ventures." CRIEFF Discussion Paper 9915, Centre for Research into Industry, Enterprise, Finance and the Firm . <http://netec.mcc.ac.uk/BibEc/data/Papers/sancrieff9915.html>

project.[10] The calculated value of a potential investment is inversely related to the discount rate. So, if the MMS's use of 8 percent to evaluate selected tracts in a lease is too low to reflect the risk of drilling the tracts, their post-sale fair market valuation of the tracts will be biased high and not as fair as MMS might believe.

4 Published Industry Discount Rates are Inappropriate to Apply to a Marginal New Investment Decision

Linking required return to risk is one of the most important problems in finance. The broadly accepted theoretical approach for addressing this issue is the Capital Asset Pricing Model (CAPM). CAPM formulates a linear relationship between investors' required return and *beta*, where *beta* is a function of the volatility of the firm's equity value and its correlation with the market. *Beta,* as discussed above, can be described as a measure of the firm's riskiness relative to a market index (such as the S & P 500). *Beta* is uniquely associated with specific financial assets, such as a firm's common stock. Use of industry average *betas* for valuation purposes should carefully match selected industries to firms with closely matched activities and, hopefully, similar *betas*. *Beta* values are available from external data sources provided by Merrill Lynch, Value Line, Ibbotson and others, who calculate, tabulate and provide *beta* estimates for all traded firms. As these are reported values, they are historic numbers and represent actual realized results.

Virtually every valuation measurement methodology depends on the elements of this conceptual approach in some form. According to MMS,[11] their discount rates to account for risk are based on Ibbotson's survey of Weighted Average Cost of Capital (WACC) data for the SIC 131, Crude Petroleum and Natural Gas Extraction,[12] and SIC 291,

[10] IRR = internal rate of return; NPV = net present value. Any number of financial texts describes project feasibility analysis using these methods. See Robert E. Megill, Exploration Economics, 3rd ed. Pennwell Books, 1988; James C. Van Horne, Financial Management & Policy, 12th ed., Prentice Hall, 2002.

[11] Email to author 8/28/03.

[12] Establishments primarily engaged in operating oil and gas field properties. This includes all activities in the preparation of oil and gas up to the point of shipment from the producing property.

Petroleum Refining.[13] Inspection of the firms Ibbotson tabulates within each of the two SIC groups reveals that SIC 131 includes a number of E&P companies; SIC 291 includes the integrated majors and refining companies. The CAPM *beta* is implicit to Ibbotson's estimates of WACCs for industry groups. MMS's selection of a discount rate based on Ibbotson's data embeds three conceptual errors that undermine their calculated MROVs for LS 185. Each is discussed in the following subsections.

4.1 Reported historic industry measures of risk do not measure the risk of a new Investment.

A fairly common valuation error occurs when CAPM estimates of required shareholder returns are applied to investment questions; i.e., the firm's *ex ante* decisionmaking discount rate for individual projects is confused with the observed *ex post* realized rate of return by shareholders of the firm. This assumption fails to recognize that shareholder views of risk for the entire firm differ fundamentally from firm decisionmakers' views of the risk of individual projects. The resultant error assumes that (1) shareholder risk (measured by CAPM's *beta*) is equal across all of the firm's activities; and (2) the marginal risk of new investments is identical to existing firm activities. Observed firm risk measures are historic averages of performance and poor indicators of the risks for new investments unless the firm merely is replacing existing assets to make the same widgets.

Shareholders are exposed to the entirety of the value distribution of the firm; so they are concerned more with the "fat part" of the distribution than with the tails. Firm decision makers evaluate projects, in some cases, that affect the central part of the firm's business, but in other cases, that affect the tails of the distribution. Historic *betas* represent the *ex post* average of the firm portfolio of existing activities, but new activities may have higher risks than existing activities even within the high end of the tail. Relying on published *betas* to determine the cost of equity will not necessarily reflect either the risk for existing activities of the firm's above average risk investments, or new activities that might represent even higher risk.

[13] Establishments primarily engaged in producing gasoline, kerosene, distillate fuel oils, residual fuel oils, and lubricants, through fractionation or straight distillation of crude oil, redistillation of unfinished petroleum derivatives, cracking or other processes.

The hurdle rate, defined as the discount rate appropriate for a project based on the project's risk, will differ from the typical firm's average risk profile. The hurdle rate is usually higher than the realized rate of return for the typical firm because some of the typical firm's portfolio of projects may earn below expectations.[14] Anticipating this outcome, decision makers require that hurdle rates for projects of comparable risk include a risk premium above the average historic return on capital.

Valuation analysts sometimes adopt the observable firm *ex post* return on equity as a discount rate to value an entire firm. Applying the observed parameter for parts of the firm, or especially, for a stand-alone project can lead to gross valuation errors if the riskiness of that part of the firm's business or, in this case, a frontier exploration project, diverges sharply from the average firmwide risk profile. MMS' use of observed WACC as a discount rate for evaluating offshore lease tracts' bonus bids falls into this error. Shareholders' risk measured by published *beta's*, implicit within published WACCs, mistates project risks. The likely direction of misstatement, when applying published WACC to evaluation of an ultra deep frontier exploration project, is understatement of the risk, which leads to overvaluation of the MROV.

4.2 Differentiated hurdle rates are essential for various classes of firm investments.

Differentiated hurdle rates are necessary for evaluating investments of different risk classes to avoid misleading value measurements, where project risks vary widely, not only across the activities of the integrated oil company, but also among exploration projects. Observed historic firm *betas* are a poor measure of risk for much of the firm's business activities, generally, and specifically for a frontier deep well project. For capital allocation among project alternatives, decisionmakers seek an *ex ante* answer; i.e., how much value will be created if the decision to allocate resources is taken? A firm that erred by using one hurdle rate to evaluate all projects competing for corporate investment dollars would end up containing a portfolio with too few low risk projects and

[14] It could be lower for a necessary equipment replacement investment whose returns are virtually certain based on long years of operation.

too many high risk projects; i.e., NPVs of low risk projects would be too low and conversely for high risk projects.

MMS' application of a "one size fits all" discount rate across lease sale bids will overstate the value of relatively higher risk exploration prospects and understate the value of prospects with lower risk. A single discount rate overstates the bonus values of relatively high risk prospects and understates values of low risk prospects. A single discount rate biases the bid evaluation process toward lower risk prospects and results in rejection of bids for higher risk prospects.

To the extent that the risk of the ChevronTexaco exploration opportunity ranges higher, generally, than the existing mix of Gulf of Mexico lease tracts, or, specifically, higher than the mix of lease tracts within Lease Sale 185, the resultant risk within MMS's 8 percent discount rate used in the bid adequacy calculations will be understated and their calculation of net present value (NPV) of the investment overstated. Indeed, two-thirds of the leased tracts were in shallow water on the shelf.[15] ChevronTexaco's rejected bids were in deep water aimed at an ultra deep drilling frontier. The "one size" discount rate does not match differential risks; this error undermines MMS's MROV calculation of the LS 185 blocks GC 468 and 512.

4.3 Averaging Upstream and Downstream Risk Overvalues Exploration Investments

MMS compounds the *ex post* selected discount rate error by selecting a published WACC that averages risk over different oil industry activities. The inherent accuracy vs. simplicity tradeoff of the use of the firm's *ex post* rate of return depends on the homogeneity or diversity of the portfolio of business activities that comprise the firm. MMS's averaging over SIC codes 131 and 291 -- the upstream and downstream elements of the oil business -- worsens the match of the exploration risk to the valuation. The risks faced by the refining and marketing integrated oil company differ

[15] MMS News Release, "Central Gulf of Mexico Sale 185 Attracts $315,531,229 in High Bids," March 19, 2003.

from those facing an E&P company.[16] The uncertain elements of a large refining unit investment are clearly less than those of a large exploration investment, and much less than a frontier exploration investment, six miles deep, and sub-salt, where even the most sophisticated seismic analysis is little more than an informed guess. As such, the upstream and downstream segments of the oil business would be expected to have different levels of systematic risk -- different *beta* values -- which is why averaging WACC over the upstream and downstream segments of the oil business is technically flawed.

Table 2 shows recent Ibbotson WACC estimates for the two industry groups. The cost of capital estimate for the exploration group is 124 basis points higher than for the refining group. Risk follows the activity and the WACCs show that market investors require a higher return for the exploration companies. Even though selected integrated majors are tabulated within the SIC 291 group, the resultant lower average required return for that group implies that required returns to the exploration activity are higher and required returns to refining and marketing are lower than the average shown as 9.19%. Averaging required returns over the two groups as MMS did is neither fish nor fowl. How, exactly, MMS calculated 8% as the average is unknown; ten percent is closer to the average. Arithmetic aside, averaging the two SIC groups understates the risk of exploration and overstates MMS' MROV calculation.

Table 2: Ibbotson WACC Estimate

SIC 131, Exploration and Production	10.43%
SIC 291, Refining and Marketing	9.19%
Average	9.81%

Source: Ibbotson, median CF estimate, June 2003.

5 Conclusions: Discount Rate Shortcomings Bias FMV calculations against high risk frontier targets, Undermine Stated MMS Policy and U.S. Energy Policy

[16] The decision to spend $50 million to upgrade a refinery for cracking a heavier crude slate clearly invokes different sources of risk than the decision to spend $50 million on an expensive offshore drilling prospect.

MMS' errors in choice and use of an 8 percent discount rate reveal that MMS's estimate of MROV will overstate the "true" value, everything else equal,[17] of the rejected two ChevronTexaco blocks in LS 185. Four Socratic questions emphasize the inaccuracy of using published *ex post betas* or WACCs as a hurdle rate for evaluating adequacy of bonus bids for ultra deep lease tracts:

1 What would be the bidding firm's average hurdle rate for an individual investment in typical replacement assets?

2 What would be the bidding firm's average hurdle rate for an individual investment in a typical exploration project?

3 What would be the bidding firm's marginal hurdle rate for a project with risks different from the average of existing assets, or the average of existing exploration projects, or, for an investment in an offshore well in a frontier situation, e.g., >30,000 feet BML, where no one else has drilled before?

4 How much should the bidding firm's marginal hurdle rate for an ultra deep exploration target differ from its standard hurdle rate? In the case of MMS MROV after-the-fact valuations, how much higher should the discount rate be to value an ultra deep high risk tract?

The four questions reveal the increasing risk profile that lease sale bidders face to illustrate the error of using published firm wide cost of capital estimates as the basis for MMS's discount rate. The "correct" hurdle rate for each of the above questions accurately reflects the minimum amount that the firm must earn on its portfolio with the new investment in order to leave the market price of its stock unchanged. Notice that question 3 invokes a marginal rate compared to average rates for average projects assumed in questions 1 and 2. The fundamental problem with use of published WACC is that reported WACC do not accurately measure the marginal risk of a forward-looking frontier investment. It overlooks necessary *ex ante* internal risk premia to meet *ex post* required investor expectations.

Question 4 reveals the overwhelming challenge of frontier ultra deep drilling investment risk assessment. Valuation of frontier prospects is troublesome because they face the same business risks as every other tract in the sale. They also face frontier technology

[17] Or, ceteribus paribus.

risks that are high but not amenable to standard methods of risk appraisal because of lack of data. The latter is true because the statistical track record to appeal to is sparse. Subjective appraisal of risk is needed, which may depend on the best available yardstick comparisons and expert evaluations by technology specialists. MMS specialists and industry experts clearly can differ on the amount of risk premium that should apply in the absence of data.

The only certain conclusion that can be drawn is that clearly the discount rate for an ultra deep prospect should reflect higher risk than more common targets. In other words, *ex post* industry parameter values, such as Ibbotson's WACC, cannot possibly reflect an adequate level of risk for a target 32,500' BML. Reliance on *ex post* published Ibbotson WACC (assumed by MMS to be 8 percent even though 10 percent appears closer to the average) to support MMS' choice of *ex ante* discount rates misapplies the historic average shareholder risk of the entire upstream and downstream petroleum industry to the marginal exploration risk in a high risk frontier investment viewed by firm decision makers. Applying the single 8 percent discount rate across the entire LS 185 is contrary to MMS claims about deep wells being "high risk." An average discount rate is not a high risk discount rate. Higher risk prospects in a lease sale should be discounted with a higher risk premium in the bid adequacy evaluation process.

Using the constant 8 percent discount rate to value prospects of varying risk in a lease sale is contrary to good national energy policy because it is biased against high risk frontier prospects and it delays, or possibly even loses, potential production of much needed new energy supplies. To answer the question posed in the opening paragraph, MMS did not provide a valuable service for the taxpayers if technical innovation necessary to open the ultra deep drilling frontier and promote needed energy production were delayed because of theoretical and practical flaws in its valuation methods. MMS' stated policy[18] of encouraging deep well drilling is inconsistent with the single discount rate used in its post Lease Sale 185 evaluation of bid adequacy. Risk

[18] See 30 CFR Part 203, "Relief or Reduction in Royalty Rates--Deep Gas Provisions;" Proposed Rule, March 26, 2003. While designed to stimulate operators on the shallow water Gulf of Mexico Shelf to drill for deep gas pockets, the planned relief applies to wells below 15,000 ft.

differences for ultra deep targets among prospects within a lease sale should be accommodated by revising bid adequacy evaluation procedures to include a range of discount rates that correct for shortcomings discussed within this article.