Accounting for Uncertainty in Discounted Cash Flow Valuation of Upstream Oil and Gas Investments[*]

by *William H. Knull, III, Scott T. Jones, Timothy J. Tyler & Richard D. Deutsch*[**]

Valuing future income streams from the production of oil and gas is a well-developed discipline within the industry and among sophisticated investors. Valuations drive companies' investment decisions and market transactions every day. In the context of resolving disputes, especially international ones, arbitral tribunals are frequently called on to perform a similar exercise: to determine a lump-sum damages award to compensate for the loss of an income-producing asset. Both the arbitrators' decision and the industry's evaluation entail converting projected future net revenues of an income-generating property to present value. However, the details of how to make that conversion remain arcane to the legal non-specialist who nonetheless must advocate or adjudicate a claim based on such calculations.

Recent scholarship has made progress in illuminating the doctrines governing the award of compensation in international commercial and treaty-based arbitrations.[1] Many

---

[1] *E.g.*, T.W. Wälde & B. Sabahi, *Compensation, Damages and Valuation in International Investment Law*, TRANSNAT'L DISP. MGMT. (forthcoming); Irmgard Marboe, *Compensation and Damages in International Law – The Limits of "Fair Market Value"*, 7 J. WORLD INV. & TRADE 723 (2006); John Y. Gotanda, *Recovering Lost Profits in International Disputes*, 36 GEO. J. INT'L L. 61 (2004); W. Michael Reisman & Robert D. Sloane, *Indirect Expropriation and Its Valuation in the BIT Generation*, in 74 BRIT. Y.B. INT'L LAW 115 (2004); Louis T. Wells, *Double Dipping in Arbitration Awards? An Economist Questions Damages Awarded to Karaha Bodas Company in Indonesia*, 19 ARB. INT'L 471 (2003); Markham Ball, *Assessing Damages in Claims by Investors Against States*, 16 ICSID REV. – FILJ 408 (2001). The

of these articles are grounded in the *Chorzów Factory* decision or its national-law analogs and their common principle of restoring the injured party to the position it would have occupied had the wrong at issue never occurred. This scholarship has attempted to provide a universal analytical framework for determining the appropriate method for calculating compensation. However, because of the breadth of these efforts, many of the details that arise in calculating damages in a dispute over oil and gas properties, as well as other assets, remain unresolved.

We will focus on one such critical detail. Specifically, we will analyze the procedures essential to the Discounted Cash Flow ("DCF") method of valuation for accounting for uncertainty in the life of a project and the risk that projected lost revenues would not have been earned as projected. The problem is familiar and can have an enormous impact on value, especially for projects located in regions where disputes are likely to arise. Under economic and financial theory, the proper method for accounting for risk is clear. But, as reflected in the relatively few reported cases to have addressed the issue squarely, that theory in important respects and in the circumstances of many hydrocarbon investments lacks objective processes, criteria and/or data to guide parties, counsel and tribunals in its systematic and predictable implementation in the context of individual disputes. The result can be a lack of transparency and a substantial range for

---

preceding list is of course incomplete; however space constraints prohibit a complete listing of the recent, insightful scholarship.

Some scholars assert that the terms "compensation" and "damages" are associated with the legality of the actions giving rise to the dispute and should thus differ in usage. *E.g. Marboe*, *supra*, at 725-26 (asserting that "in certain cases the use of one term [compensation or damages] might be more appropriate than the other" based on the legality of the actions underlying the dispute). This paper does not consider the legality of the actions underlying the dispute. *See infra* text accompanying note 2. The two terms are thus synonymous for the purposes of this paper and are used interchangeably.

subjectivity with respect to an issue that, in some instances, could have effects measured in hundreds of millions of dollars.

In order to focus on the single issue of determining the equivalence between present and projected future values in the face of uncertainty, we will address only the question of how to convert projected lost revenues as of a certain date to an equivalent, lump-sum cash award. This starting point necessarily presumes only the involuntary loss of a contract or property or rights. We do not consider the legal nature of the wrong occasioning that loss or other potential components of damages.[2]

---

[2] The mathematical models for determining the present value equivalent to projected future revenues derive from economic and financial considerations, not from the legal principles determining a claimant's right to compensation for loss of those revenues. ASWATH DAMODARAN, INVESTMENT VALUATION, TOOLS AND TECHNIQUES FOR DETERMINING THE VALUE OF ANY ASSET 11-14 (2d ed. 2002) (providing the mathematical formula for the discounted cash flow method of valuation which does not depend on the legality of a respondent's act); FREDERICK S. MISHKIN, THE ECONOMICS OF MONEY, BANKING, AND FINANCIAL MARKETS 71-72 (4th ed. 1995) (same); RICHARD A. BREALEY & STEWART L. MYERS, CAPITAL INVESTMENT AND VALUATION (2003).

However, the applicable law governing compensation may in certain circumstances require adjustment of the calculation based on the nature of the wrong. For example, a tribunal recently held that an illegal expropriation of an asset that *increases* in value after the expropriation should result in compensation as of the date of the award, rather than at the time of the expropriation. *ADC Affiliate Ltd et al. v. Hungary*, ICSID Case No. ARB/03/16, at ¶¶ 479-81, 496-99, & 517-21 (Award of 2 October 2006), *available at* http://www.worldbank.org/icsid/cases/pdf/ARB0316_ADCvHungary_AwardOctober2_2006.pdf (last visited June 6, 2007).

The tribunal's conclusion is a recognition that, from a legal perspective, the measure of damages may vary depending on the nature of the wrong giving rise to the right to recovery and the remedy for that wrong. Compensation for a loss, for example, requires making the claimant "whole" for its loss (whatever that may mean), while disgorgement focuses on depriving the wrongdoer of the benefit of its wrong. Similarly, scholars and tribunals have suggested that awards premised on illegal acts should be greater than an award for a legal act with comparable economic effect. Marboe, *supra* note 1, at 725-26 (supporting this view and distinguishing between compensation as a result of a legal act and damages arising "as the consequence of a breach of an obligation, be it international or contractual"); *see also Case Concerning the Factory at Chorzów (Germany v. Poland)*, 1928 P.C.I.J. (ser. A) No. 17, at 40 (Sept. 13) (stating that a failure to distinguish legal from illegal acts "would . . . be unjust . . . since it would be tantamount to rendering lawful liquidation and unlawful dispossession indistinguishable in so far as their financial results are concerned."). This rationale points to a measure of damages intended either to punish the wrongdoer or to deter other wrongs, as might be employed to differentiate damages awarded in cases of illegal, as distinct from lawful, expropriation. *See, e.g.*, Separate Opinion of Judge Brower, *Sedco, Inc. v. Nat'l Iranian Oil Co.*, Interlocutory Award, No. ITL 59-129-3 (27 Mar. 1986), *reprinted in* 10 IRAN-U.S. C,T.R. 189, n.35 (1986) (stating "the injured party would receive nothing additional for the enhanced wrong done it and the offending State would experience no disincentive to repetition of unlawful conduct"); *see also* Gotanda, *supra* note 1, at 62-66 (detailing the underlying theories for recovery of a breach of contract in a variety of jurisdictions). While such considerations could have significant impact on the damages awarded, they do

I.   COMPENSATION FOR LOSS AND THE PRINCIPLE OF EQUIVALENCY.

Both international and national laws accept that damages should equal the amount that would place the claimant in an economic position as close as possible to the position that it would have occupied had the wrong not occurred.[3] In modern public international law, this principle traces back to the decision of the Permanent Court of International Justice in the *Chorzów Factory* case delivered almost eighty years ago:

> The essential principle contained in the actual notion of an illegal act – a principle which seems to be established by international practice and in particular by the decisions of arbitral tribunals – is that reparation must, as far as possible, wipe out all the consequences of the illegal act and re-establish the situation which would, in all probability, have existed if that act had not been committed.[4]

The same standard pertains in damage provisions of most legal systems.[5]

---

not affect the method of determining the present value equivalent of a given stream of future revenues, other variables being held constant.

[3] Wells, *supra* note 1, at 473 ("In most involuntary or efficient takings of investments, the goal of compensation ought to be to leave the investor in the same position it would have been in had the property not been taken."); *Himpurna California Energy Ltd. v. PT. (Persero) Perusahaan Listruik Negara,* (Award of 4 May 1999), XXV Y.B. COMM. ARB. 13, at ¶ 275 (2000) (citation omitted); Paul D. Friedland & Eleanor Wong, *Measuring Damages for the Deprivation of Income-Producing Assets: ICSID Case Studies*, 6 ICSID REV.—FILJ 400, 404 (1991) (asserting that "it is generally accepted that the relevant value is *the value of the asset to the investor* who has been deprived of it. . . .", and "the measure of the value of an asset to the investor should be the price that a willing buyer would have paid to a willing seller . . . ."); William C. Lieblich, *Determining the Economic Value of Expropriated Income-Producing Property in International Arbitrations*, 8 J. INT'L ARB. 37, 40 (1991) (citing *Lena Goldfields, Ltd. v. U.S.S.R.*, excerpted in 36 CORNELL L.Q. 31, (1950), and stating that compensation should equal "the present value, if paid in cash now, of future profits which the company would have made and which the Government now can make—on the assumption of good commercial management and the best technical skill and up-to-date development."); *Sapphire Int'l Petroleums Ltd. v. Nat'l Iranian Oil Co.*, 35 INT'L L. REP. 136, 185-86 (1967) (stating that "according to the generally held view, the object of damages is to place the party to whom they are awarded in the same pecuniary position that they would have been if the contract had been performed in the manner provided for by the parties at the time of its conclusion.").

[4] *Chorzów Factory*, 1928 P.C.I.J. (ser. A) No. 17, at 40. The Permanent Court of International Justice was the precursor of today's International Court of Justice.

[5] *See, e.g.*, Friedland & Wong, *supra*, note 3 at 404 (asserting that "it is generally accepted that the relevant value is *the value of the asset to the investor* who has been deprived of it. . . .", and "the measure of the value of an asset to the investor should be the price that a willing buyer would have paid to a willing seller . . . .") (emphasis added); Todd Weiler & Luis Miguel Diaz, *Causation and Damages in NAFTA Investor-State Arbitration*, *in* NAFTA INVESTMENT LAW AND ARBITRATION: PAST ISSUES, CURRENT PRACTICE, FUTURE PROSPECTS 188-94 (Weiler ed., 2004); Wells, *supra* note 1, at 473; Draft Articles on Responsibility of States for Internationally Wrongful Acts, Art. 36 & cmt., *reprinted in* JAMES CRAWFORD,

Because *Chorzów Factory*'s preferred alternative – restitution of the asset actually lost – is usually impracticable, compensation in the form of a monetary payment is usually the only way of "re-establish[ing] the situation which would, in all probability, have existed had that act not been committed."[6] To successfully apply the *Chorzów Factory* principle, then, compensation must be the monetary sum that in present value terms is equivalent to the value that the claimant lost.[7] Equivalence is attained when a reasonable claimant would be as nearly as possible indifferent between the monetary compensation and the *status quo ante* (*i.e.*, ownership of the asset just before the wrong occurred).[8] As one commentator expressed it, "[t]he very purpose of such an award is to

---

THE INTERNATIONAL LAW COMMISSION'S ARTICLES ON STATE RESPONSIBILITY: INTRODUCTION, TEXT AND COMMENTARIES 225 [hereinafter I.L.C. COMMENTARY] (stating that the "reference point for valuation purposes is *the loss suffered by the claimant* whose property rights have been infringed.") (emphasis added); *Sapphire Int'l Petroleums Ltd. v. Nat'l Iranian Oil Co.*, 35 ILR at 185-86 (stating that "according to the generally held view, the object of damages is to place the party to whom they are awarded in the same pecuniary position that they would have been if the contract had been performed in the manner provided for by the parties at the time of its conclusion."); UNIDROIT Principles of International Commercial Contracts (2004) art. 7.4.2, *available at* http://www.unidroit.org/english/principles/contracts/main.htm (last visited June 6, 2007); United Nations Convention on the Law Applicable to Contracts for the International Sale of Goods, Apr. 11, 1980, S. Treaty Doc. 98-9 (1983), 19 I.L.M. 668 (1980); *Dir. of Buildings and Lands v. Shun Fung Ironworks Ltd.* [1995] 2 A.C. 111, 125; HARVEY MCGREGOR, MCGREGOR ON DAMAGES 1-021 (17th ed. 2004) (stating that the "object of damages is to give the claimant compensation for the damage, loss or injury he has suffered) (citations omitted); The Principles of European Contract Law Art. 9.502, *available at* http://www.jus.uio.no/lm/eu.contract.principles.1998/doc.html (last visited June 6, 2007); DOBBS LAW OF REMEDIES 281 (2nd ed.) (stating that, in U.S. law, the "plaintiff should be fully indemnified for *his loss*, but that he should not receive any windfall.") (emphasis added).

Cases have also indicated that, where a domestic compensation standard is applicable and would grant less compensation than international law, the latter should apply. Ball, *supra* note 1, at 412 (citing *Compania Del Desarrollo De Santa Elena, S.A. v. Costa Rica*, ICSID Case No. ARB/96/1, *reprinted in* 15 ICSID REV. – FILJ 167, at ¶ 64 (2000)). Whether the international law compensation standard could act to limit a more generous national law compensation standard remains an open question. *Id.* at 413.

[6] *Chorzów Factory*, 1928 P.C.I.J. (ser. A), No. 17, at 48. Restitution is often impracticable or insufficient to satisfy the *Chorzów Factory* standard. I.L.C. COMMENTARY 213-17 (discussing Art. 35 of the Draft Articles and noting that restitution may not be available or sufficient); Wälde & Sabahi, *supra* note 1.

[7] *See supra* note 5.

[8] Indifference is a part of the concept of utility in economics. It is the way individuals and asset managers reveal their preferences. ROBERT S. PINDYCK & DANIEL L. RUBINFELD, MICROECONOMICS 73-89 (2d ed.).

enable the claimant to replace his expropriated property [with] one that is capable of producing the same cash flows, no more and no less."[9]

As is often the case with such broad statements of principle, this seemingly straightforward path is less clearly marked when it comes to specific application. Difficult subordinate considerations must be taken into account. For example,

- Parties subjected to the same loss may experience different impacts;

- The loss to the victim of the wrong may or may not be equal to the benefit of the wrong to the wrongdoer;

- The legal basis for liability – ranging from breach of contract (the law between the parties) to violations of national and international law – may implicate different policies and different measures of damages; and

- The mere fact of the breach and its consequences may make similar actions more or less likely in the future.

In the main, we shall disregard these corollary questions in order to focus on the question of determining equivalence between projected future revenues and lump sum damages.

II. THE DISCOUNTED CASH FLOW METHOD IN BRIEF.

Tribunals have used numerous methods in attempting to restore the injured claimant to the position it would have occupied had the wrong not occurred.[10] It is widely accepted that an investment's value usually lies in the future cash flows it was expected to produce.[11] Compensation that fails to make up for the loss of those future

---

[9] Lieblich, *supra* note 3, at 64.

[10] *E.g.*, Jan Paulsson, *The Expectation Model*, *in* EVALUATION OF DAMAGES IN INTERNATIONAL ARBITRATION 58 (Yves Derains & Richard H. Kreindler eds. 2006) (stating that *Chorzów Factory* does not specify if the damages model is "one of rescission or expectation"); Wälde & Sabahi, *supra* note 1 (noting *Chorzów Factory*'s failure to specify a means of calculating what it deems appropriate compensation).

[11] *E.g.*, DAMODARAN, *supra* note 2, at 730 ("The value of any cash-flow-producing asset is the present value of the expected cash flows on it."); Ball, *supra* note 1, at 419-20 (noting testimony by Professor Stewart Myers in *Phillips Petroleum Co. v. Iran* that confirmed that the "market value of an asset equals its

cash flows is inadequate.[12] While projecting the future cash flows of start-up enterprises and early-stage investments is open to legitimate skepticism, revenue projections for "going concerns"[13] are generally considered sufficient bases for an award of damages when there is clear proof of the fact of damages and some reasonable basis for the estimation of lost revenues.[14] Where that is the case, the DCF methodology is commonly accepted as the principal approach to valuing a claimant's lost or damaged going concern,

expected future cash flows discounted to present value at the opportunity cost of capital" and noting that the discounted cash flow analysis has "been accepted and applied in the awards of numerous international arbitral tribunals, as well as in cases in national courts."); Lieblich, *supra* note 3, at 60-61 (1991) (stating that "the value of an income-producing capital asset or enterprise to its present owner or to a potential private purchaser is a function of the cash that the asset or enterprise is expected to generate in the future").

The terms "cash flow" and "net revenues" refer to the after-tax difference between dollars received and dollars paid out. These terms should, thus, be considered outside any accounting or financial reporting concept, such as "profits," which may incorporate differences in accounting practices between jurisdictions, parties, projects, or individual assets. *E.g.*, BREALEY & MYERS, *supra* note 2, at 104.

[12] Lieblich, *supra* note 3, at 64 (discussing *Amoco Int'l Fin. Corp. v. Iran* and stating that "[t]he very purpose of such an award is to enable the claimant to replace his expropriated property which (sic) one that is capable of producing the same cash flows, no more and no less.").

[13] The question of what does or does not qualify as a going concern in the context of hydrocarbon-producing properties is a complex inquiry and is not within the scope of this paper, which will assume the evaluation of a property sufficiently developed to permit the projection of future production and associated costs and revenues with reasonable certainty. For discussion of the jurisprudence of what constitutes a going concern and the manner in which that determination affects the choice of valuation methodology, see generally Marboe, *supra* note 1, at 735; *Faith Lita Khosrowshahi v. Iran*, Award No. 558-178-2 (30 June 1994), *reprinted in* 30 IRAN-U.S. C.T.R. 76, at ¶ 44 (1994); Resubmitted Case: *Amco Asia Corp. v. Indonesia*, ICSID Case No. ARB/81/1, Award of 31 May 1990, 1 ICSID REP. 569, at ¶¶ 167-200; Gotanda, *supra* note 1, at 93-95; Friedland & Wong, *supra* note 3, at 405; Wälde & Sabahi, *supra* note 1; Ball, *supra* note 1, at 422-23; World Bank, Guidelines on the Treatment of Foreign Direct Investment § A.IV.6, *reprinted in* IBRAHIM F.I. SHIHARA, LEGAL TREATMENT OF FOREIGN INVESTMENT: THE WORLD BANK GUIDELINES 162 (1993); *Wena Hotels, Ltd. v. Egypt*, ICSID Case No. ARB/98/4, Award of 8 Dec. 2000, 41 I.L.M. 896 (2002), at ¶¶ 122-25; *Metalclad Corp. v. United Mexican States*, ICSID Case No. ARB(AF)/97/1, Award of 30 Aug. 2000, 16 ICSID Rev. – FILJ 168 (2001), at ¶¶ 119-20. Whether a hydrocarbon-producing property constitutes a going concern should also be informed by the industry's inelastic demand, which assures the presence of a market for any produced reserves, and the expertise with which the oil and gas industry performs its profit and reserve estimates.

[14] *See* Ball, *supra* note 1, at 422-23 (stating that one problem in performing a discounted cash flow analysis is one of sufficient evidence as to net cash flows, and noting that the World Bank *Guidelines* require that an asset be a "going concern with a proven record of profitability" in order to perform a discounted cash flow analysis) (citing World Bank, § A.IV.6, *supra* note 13, at 162); Lieblich, *supra* note 3, at 77-78 (explaining that one of the benefits of the discounted cash flow method is "its explicit recognition and treatment of risk and uncertainty as part of the valuation process" and that "financial data concerning" similar enterprises may provide a metric of the "uncertainty with respect to a specific enterprise's cash flows.").

including upstream oil and gas investments.[15]   While the DCF methodology may be

corroborated by other reliable indicators like comparable sales,[16] it is the most reliable

means to measure value in situations where (as in oil and gas properties) it may be

difficult or impossible to find sales of comparable properties.

A.   Determining the Present Value of Projected Future Revenues.

It is axiomatic that a dollar paid today is worth more than a dollar recoverable in

the future, in part because money in hand today can be invested so as to be worth more at

a date in the future. A dollar in hand today is also worth more than a dollar payable in

the future because of the risk that money projected to be earned in the future will not be

realized. Converting projected future net revenues to present value requires taking both

---

[15]   *See* Marboe, *supra* note 1, at 735-36 (stating that the DCF method is the most common method for determining fair market value); Wälde & Sabahi, *supra* note 1 (stating that the DCF method is "currently dominant"); Friedland & Wong, *supra* note 3, at 427.

[16]   Ball, *supra* note 1, at 424 (stating that "[a]rbitrators, even if they lean toward accepting a DCF analysis, are cautious. They tend to look for help from other sources" and noting that NAFTA article 1110 permits arbitrators to look at "other criteria, as appropriate, to determine fair market value.") (citation omitted); *see also Phillips Petroleum Co. Iran v. Iran*, Award No. 425-39-2 (29 June 1989), *reprinted in* 21 IRAN-U.S. C.T.R. 79, at ¶ 111-165 (analyzing the discounted cash flow analysis performed by the claimant and performing an alternative "underlying asset valuation approach").

The late Thomas Stauffer also made the provocative assertion that, given certain conditions, the inflation-updated book value, market price, and net present value of the DCF method should all be similar in value. *See generally* Thomas Stauffer, *Valuation of Assets in International Takings*, 17 ENERGY L.J. 459 (1996). However, as other scholars have noted, this assertion was based on assumptions including the absence of inflation between the time of the investment and the award; adjusting for real depreciation; the presence of normal profits; and research and development being treated as an investment rather than a cost. *See* Wells, *supra* note 1, at n.14; Marboe, *supra* note 1, at 737, n.83. The practical effect of Stauffer's point may also be undercut because "book value," as used in the petroleum industry, is an accounting and reporting concept that is dependent upon the accounting rules and generally accepted practice of the reporting entity's jurisdiction. *See* Marboe, *supra* note 1, at 737, n.83. Given these reservations, this assertion has not gained wide support in valuation theory or been widely accepted by international tribunals. *See id.* (stating that it "remains to be seen if [the asserted equivalence of book value] will find wider support in valuation theory and in the practice of international tribunals."). The inadequacy of book value as compensation may be seen most easily in contrasting the value resulting from initial expenditures that result on the one hand in drilling a dry hole and on the other in proving up a substantial find: expenditures that are, to a point, equal, may lead to dramatically different values, and the value of the upside in the successful field will not normally be reflected in amounts expended absent a subsequent sale. Put another way, no successful company invests money simply in the hope of recovering the amount of its investment. Book value is thus highly unlikely to bear any resemblance to the full value of a proven hydrocarbon property.

aspects – time value and risk – into account.[17] Valuing lost revenues thus requires

projecting the amount and timing of those revenues on some reasonable basis and then

converting those projections to a single, lump-sum present value.[18]

Mechanically, the estimation of the present value of expected future revenues

involves both the projection of net revenues and the application of a discount rate –

effectively the converse of an interest rate used to project the future value of a sum

invested in the present.[19] The size of the discount rate is inversely related to the size of

the award: the higher the risk, the higher the discount rate necessary to adjust for the

likelihood that the projected revenue would not be realized and the lower the present

value of the projected stream; the lower the risk, the lower the discount rate and the

higher the present value.[20] The discount rate's effect on anticipated revenues also

increases the farther into the future those revenues are expected to be received: in short,

---

[17] *E.g.*, William C. Lieblich, *supra* note 3, at.72-73, 77-78; *see also Himpurna California Energy Ltd. v. PT. (Persero) Perusahaan Listruik Negara*, Award of 4 May 1999, XXV Y.B. COMM. ARB. 13, at ¶¶ 348-78 (2000); Resubmitted Case: *Amco Asia Corp.*, 1 ICSID REP. 569, at ¶¶ 188-200.

[18] Wälde & Sabahi, *supra* note 1; Lieblich, *supra* note 11, at 70-72.

[19] The mathematical equation for calculating the net present value of a stream of future income ("NPV") is well known:

$$\text{NPV} = \sum_{t=0}^{n} \frac{C_t}{(1+r)^t}$$

Determining the NPV of a stream of income from a property, thus, requires the determination of the net revenues (C) for each time period (t) of the property's productive life and the discount rate (r).

The discount rate is represented here as a constant. It can also be a variable that fluctuates depending upon the time period which is being discounted. BREALEY & MYERS, *supra* note 2, at 187. In other words, the discount rate need not be held constant across time periods because the risks it assesses may fluctuate between time periods. *Id.* The authors are unaware of any award that differentiates between discount rates applied to different time periods of a property's productive life. Rather, awards consider the discount rate as being constant for the entirety of the property's productive life. The discount rate is, therefore, represented here as a constant.

[20] DAMODARAN, *supra* note 2, at 12 (explaining the basics of the NPV calculation and the discount rate's function).

the later the revenues will arrive, the less they are worth today.[21] The rate's impact on the present value calculation can be enormous, as illustrated in the following chart depicting the effect of varying discount rates on the value of a field expected to produce net revenues of $100,000,000 per year for 25 years:

(Dollars in millions)						
Annual Net Revenues	$100					
Duration (years)	25					
Total Net Revenues	$2,500					
Discount Rate	5%	10%	15%	20%	25%	30%
Net Present Value	$1,409	$908	$646	$495	$398	$333

B.   Projecting Cash Flows from Upstream Investments: the Reserve Estimate

The first step in estimating net revenues over the life of a hydrocarbon property is estimating reserves, a function commonly performed throughout the industry. Reserve estimates encompass the volume of hydrocarbons in the ground, the volume that can be economically produced, and the resulting net revenues. That process entails analysis of (i) available geological, geophysical and engineering data to estimate the quantities of hydrocarbons in place; (ii) estimates of the quantities of hydrocarbons that are economically recoverable; (iii) the timing of investments and production based on the development plan; (iv) the timing and amount of capital costs, operating expenses, taxes and royalties; (v) price forecasts for the hydrocarbons extracted; and (vi) the resulting net cash flows scheduled over the project's expected life.[22]

---

[21] *See, e.g.*, BREALEY & MYERS, *supra* note 2, at 16-21, 31-35; *Himpurna California Energy Ltd.*, XXV Y. B. COMM. ARB.13, at ¶ 353 (explaining this in terms of the familiar concept of compounding).

[22] These are shared components of both a property's reserve estimate and a cash flow projection for the property.

The process of estimating reserves takes into account many aspects of geologic and engineering risk. Such risk is commonly reflected in the familiar classification of reserves as proved, probable or possible.[23] In addition, the forecast of net revenues necessarily entails assumptions with respect to future prices and costs. The goal of estimating reserves is to generate estimates that are comparable between fields, regardless of their location, by using well-developed industry definitions and standards and making other assumptions explicit.

Generally speaking, reserve estimates may be deterministic, yielding a single projection of "expected" values, or probabilistic, reflecting a range of potential outcomes and the distribution of associated probabilities. The choice generally depends on the state of development of the field and the corresponding depth of information available on which to base the estimate. In general, the longer a property has been producing, the more data is available and the greater the confidence in projections of its future production.[24]

The reserve estimate projects revenues over the life of the reserves. Doing so necessitates taking into account risks that may impact the project's value. As mentioned above, the petroleum engineer's estimate takes into account geological and engineering risks that affect the volume and timing of hydrocarbons that can be economically produced. Other risks that must be accounted for include factors that affect the economy and oil and gas operations generally, including general market conditions, price fluctuations (*i.e.*, the risk that the reserve estimate's assumptions as to prices and costs

---

[23] Often with further subdivisions. *See* Society of Petroleum Engineers, "Petroleum Resources Management System," *available at* http://www.spe.org/spe-site/spe/spe/industry/reserves/Petroleum_ Resources_Management_System_2007.pdf (last visited June 6, 2007).

[24] *See id.*

will prove to have been incorrect), and the like. In addition, individual assets may be subject to localized or regional risks not shared by the international market more generally, particularly in remote and unpredictable regions in which unexplored oil and gas prospects are increasingly found. These risks include, *e.g.*, political risk (changes to legal and regulatory regimes; partial or complete expropriation; involuntary changes to investment terms; political violence; war; export and currency controls; etc.), market risk (availability of transportation, internally and cross-border; regional economic conditions; solvency of regional suppliers and customers; etc.) and natural risk (extreme weather, earthquake, etc.). Some risks may be subject to exclusion from the valuation process for legal or equitable reasons. For example, it is generally considered inappropriate to reduce the value of an investment for the risk that the other party will breach its agreement or, in the case of a host government, will violate assurances in investment agreements or treaties, as by expropriation of the interest that is the subject of the claim.[25] Generalized and local risks may not be discrete: all may apply to some extent wherever a project is located, but local conditions may increase risk materially above the average.

C. Adjusting for risk

The mandate to put the claimant in the position it would have occupied but for the wrong requires care in assuring insofar as practicable that the effect of all applicable risks on projected revenues is accounted for without double counting. Failure to adjust for risk results in a value as if the projected outcomes had been certain, and thus over-compensates the claimant, which has lost an investment that, however promising, faced real uncertainty. Too great an adjustment for risk, on the other hand, results in under-

---

[25] *See Phillips*, 21 IRAN-U.S. C.T.R. 79, at ¶ 152; *Himpurna California Energy Ltd.*, XXV Y.B. COMM. ARB. 11, at ¶ 357 (citing *Phillips*).

compensation. While the risk-adjustment process unavoidably requires judgment, it is essential that clear, reproducible procedures leading to objectively derivable and verifiable benchmarks constraining the range of permissible outcomes be developed to provide transparency, clarity and confidence in this critical step of the valuation process.

As detailed above, the present value calculation is a function of expected revenues and the discount rate or rates. The expected value of an uncertain possible outcome is crudely expressed as the value of the outcome times its probability. A lottery with a prize of $1 million and a likelihood of winning of one in one hundred million has an expected value of $0.01, exclusive of time-value considerations; the investment of $1 to buy a ticket would show a net expected loss of $0.99. Unlike a lottery, however, the uncertainties facing a producing oil and gas property in a high-risk part of the world are not finite and not subject to precise measurement or estimation: one cannot determine the probability of success by knowing the number of equally likely outcomes, or, in the lottery example, the total number of tickets sold. As a result, determining the expected cash flows from oil and gas production in regions of higher-than-usual risk requires analysis that does not always yield a unique answer from objective data.

To put a value on future revenues, economic theory looks first to the market as the most comprehensive evaluation of available information. The market's evaluation is based on the self-interest of all the participants in the market and is not dependent on positions crafted by parties or their experts for purposes of dispute resolution. Reference to the market, moreover, conforms to one important formulation of the objective of damages, namely that of awarding that sum of money, no more and no less, that will allow the claimant to acquire a replacement revenue stream comparable in magnitude,

duration and level of risk to that which was lost. But reference to the market to determine

the discount rate to convert risk-adjusted expected cash flows to present values entails at

least two fundamental problems.

First, widely accepted financial and economic theory prescribes discounting at the

opportunity cost of investment, specifically the weighted average cost of capital

("WACC") for the individual project being valued. But the WACC does not purport to

embody all of the risks intrinsic to a particular asset: the market assumes that risks unique

to the individual asset can and will be offset by investment in a diversified portfolio.[26]

As a result, the WACC reflects only systematic or market risk, that risk that cannot be

avoided by diversification. Non-systematic risks, which are those peculiar to the

individual asset, are assumed by the market to be "diversified away," that is, offset by

other, independently varying assets held in a diversified portfolio.[27] Thus, the WACC

does not purport to provide a measure of <u>all</u> risks affecting the likelihood of recovering

the revenues projected for a particular asset. As a result, further adjustment must be

made, either through revising the cash flows themselves or through refinement of the

discount rate to more closely approximate the full range of risks faced by the project.

Either adjustment necessarily entails insertion of more subjective judgment. Moreover,

particular care must be taken to avoid double-counting for risk, particularly in adjusting

cash flows, since the dividing line between systematic and non-systematic risk that must

be observed to avoid over- or under-compensation is rarely entirely clear.

---

[26] *See, e.g.*, Brealey and Myers, <u>*supra* </u>note 2, at 185 ("Each project should be evaluated at its own opportunity cost of capital"); *id.* at 393 (explaining that the WACC is the correct discount rate for projects that are "carbon copies of the existing firm" and have "the same business risk . . . .").

[27] *See infra* notes 35, 38, and 39.

Second, upstream oil and gas projects in remote locations are rarely if ever financed on a standalone basis through publicly traded securities. As a result, it is nearly impossible to obtain the WACC of the project itself directly from market data. Instead, it is generally necessary to look to the most closely analogous publicly available entities operating in the same country or region. Moreover, markets in which equity and debt of entities comparable to the lost project are traded are likely not to be integrated perfectly into world capital markets and to be too thinly traded over too short a history to yield statistically reliable data to establish value. Since there is unlikely to be a close correlation between the available analogies and the project being valued, further adjustment will have to be made to account for the difference. Economic theory mandates that adjustment for particularized risk be made through further adjustment to cash flows.

D. Market-Based Discount Rates

The discount rate converts expected cash flows for future time periods into present values[28] that can be aggregated to consolidate a claimant's anticipated profit stream into a single lump sum of current dollars.[29] The sum of the present value of future cash flows is the lump sum of money to be awarded as compensation that is equivalent in value to the lost future revenues as of the date determined in accordance with the law governing the award of damages.[30]

---

[28] *E.g.*, Lieblich, *supra* note 3, at 71-73, 77-78; *see also Himpurna California Energy Ltd.*, XXV Y.B. COMM. ARB. 11, at ¶¶ 348-78; Resubmitted Case: *Amco Asia Corp.*, 1 ICSID REP. 569, at ¶¶ 188-200.

[29] Wälde & Sabahi, *supra* note 1; Lieblich, *supra* note 3, at 70-72.

[30] This is the result of a discounted cash flow analysis. *See, e.g.*, Friedland & Wong, *supra* note 3, at 407 (noting that "[t]he sum of the present values of the net cash flows for each of the future years is the value of the asset or enterprise as determined by the DCF method."). Note that inflation must be accounted for consistently, *i.e.* cash flows expressed in nominal terms should be paired with a discount rate that incorporates inflation.

In determining damages in litigation or arbitration, economic theory prescribes that future revenues be discounted to present value at the "opportunity cost of capital," a rate equal to the WACC for the project under valuation.[31] The measure incorporates the cost of equity and debt, weighted to reflect the assumed capital structure.

1.   Calculating the Property's WACC: The Cost of Equity

The property's cost of equity is estimated using the Capital Asset Pricing Model ("CAPM").[32]   The CAPM predicts a relationship between expected returns and systematic risk by comparing the market performance of a specific asset to the performance of equity securities in the market at large.[33] This measure is then used to calculate the difference between the expected return on the asset's equity and the risk-free rate of return.[34]

---

[31] BREALEY & MYERS, *supra* note 2, at 186; IBBOTSON ASSOCIATES, INC., STOCKS, BONDS, BILLS, AND INFLATION 2006 YEARBOOK: VALUATION EDITION 35 (2006).   Note that the relevant WACC is that of the property itself, not that of the claimant. BREALEY & MYERS, *supra* note 2, at 186; IBBOTSON ASSOCIATES, INC., *supra*, at 35.

[32] DAMODARAN, *supra* note 2, at 69 ("The risk and return model that . . . is still the standard in most real-world analyses is the capital asset pricing model."); *see also* BREALEY & MYERS, *supra* note 2, at 171 (stating that the capital asset pricing model is the "most convenient tool" but not necessarily the "ultimate truth"); IBBOTSON ASSOCIATES, INC., *supra* note 31, at 57-62 (stating that the CAPM is "among the most widely used techniques to estimate the cost of equity.").

[33] The mathematical representation of the CAPM is straightforward in application despite its unintuitive form:

$$r = R_f + \beta_{im}(E(R_m) - R_f)$$

See, e.g., BREALEY & MYERS, *supra* note 2, at 167-69 (providing the same formula with a slightly different nomenclature); DAMODARAN, *supra* note 2, at 71 (providing the mathematical formula for the capital asset pricing model again with a slightly different nomenclature).

[34] MISHKIN, *supra* note 2, at 103.

The CAPM is based on Modern Portfolio Theory,[35] which holds that market values reflect only risks that are systematic and therefore not diversifiable. A diversifiable risk can be defined as the <u>risk</u> of price change due to the unique circumstances of a specific asset, as opposed to the overall market or sector.[36] Project-specific, non-systematic risks are assumed to be offset in a diversified portfolio by investments in statistically independent assets such that a decrease in value of one is likely to be offset by an increase in another.[37] The CAPM presumes that the claimant, and all other investors in the market, will have a diversified portfolio.[38] The discount rate

---

[35] A key tenet of Modern Portfolio Theory is that a portfolio of assets will benefit from diversification as long as the returns of assets in the portfolio are imperfectly correlated (*i.e.* to the extent they do not lock-step each other). As a corollary, the benefits of diversification are limited by the extent to which individual asset returns are correlated. Investors can optimize their portfolios to maximize the expected returns for a given level of risk, or minimize the risk for a given level of expected returns. Similarly, diversification lowers the required rate of return for a given level of risk. However, not all risks are diversifiable; therefore, required returns on an asset in an optimally diversified portfolio will fall somewhere between the required return on a riskless asset and required rate of return of the asset on a standalone basis. The overall market itself can be thought of as an optimally-constructed portfolio. The result is that the market prices assets as if they were held in such a portfolio.

[36] BREALEY & MYERS, *supra* note 2, at 186 (referred to as unique risk); IBBOTSON ASSOCIATES, INC., *supra* note 31, at 57.

[37] BREALEY & MYERS, *supra* note 2, at 186 (referred to as market risk); IBBOTSON ASSOCIATES, INC., *supra* note 31, at 57; Mishkin, *supra* note 2, at 101.

[38] There are four basic assumptions underlying the CAPM: no transaction costs; all assets are traded; all investors have the same information; and investments are infinitely divisible (*i.e.* you can buy any fraction of a unit of any asset). Damodaran, *supra* note 2 at 69.

> By making these presumptions, [the CAPM] allows investors to keep diversifying without additional cost. At the limit, [the investors'] portfolios will not only include every traded asset in the market but will have identical weights on risky assets (based on their market value). The fact that this portfolio includes all traded assets is the reason it is called the market portfolio, which should not be a surprising result given the benefits of diversification and the absence of transaction costs in the [CAPM]. . . . In the CAPM world, where all investors hold the market portfolio, the risk to an investor of an individual asset will be the risk that this asset adds to the market portfolio. Intuitively, if an asset moves independently of the market portfolio, it will not add much risk to the market portfolio. In other words, most of the risk in this asset is firm-specific and can be diversified away. In contrast, if an asset tends to move up when the market portfolio moves up and down when it moves down, it will add risk to the market portfolio. This asset has more [non-diversifiable] risk and less [diversifiable] risk. Statistically, this added risk is measured by the covariance of the asset with the market portfolio.

Id. at 69-70.

for the project does not, therefore, adjust the projected cash flows for project-specific, non-systematic, "diversifiable" risk.[39]

2. Calculating the Property's WACC: The Cost of Debt

The second step in calculating the property's WACC is to derive the cost of debt for the property. In a perfectly efficient market, the nature of an asset's capital structure would not affect the rate of return required by the market for its equity. In other words, an investor would require the same return regardless of how the asset was financed.

As noted above, however, the existing market is not perfect. In particular, different tax treatment of equity and debt affects the capital structure. The cost of debt can thus be relevant because "[w]henever a company borrows money, it increases the [riskiness] (and the expected return) of its stock."[40] The size and nature of this increase can be estimated (although the means of doing so are far beyond the scope of this article) and are dependent upon a number of case-specific facts such as the applicable marginal tax rate and the types of debt (*e.g.*, bonds) that have financed the asset.[41] For purposes of this article, we can only note that in deriving the WACC for a particular asset, care must be taken with respect to the capital structure of publicly traded assets used as analogs in order to ensure their appropriateness with respect to the asset being valued.

---

[39] This conclusion is an extension of the presumptions in the preceding footnote. If it is presumed that all investors hold the market portfolio and that every investor has the same information, the market equilibrium required rate of return will not reward the assumption of diversifiable risk.

[40] BREALEY & MYERS, *supra* note 2, at 216.

[41] IBBOTSON ASSOCIATES, INC., *supra* note 31, at 15, 33 (providing, respectively, insight into the determination of the applicable tax rate and the calculation of a project's cost of debt) (citations omitted).

3. *Calculating the Property's WACC: Adjusting for International Projects*

While the preceding paragraphs summarize the standard method for calculating a property's cost of capital, the analysis requires some adaptation when applied in the international context to a project located in a country or region with a level of risk higher than that prevailing on average throughout the world. For instance, assume a U.S. company has a project in Equatorial Guinea. On the one hand, the cost of labor and less regulated infrastructure of Equatorial Guinea will lead to lower costs for the project, factors which are taken into account in the reserve estimate. On the other hand, the risks facing this project are also significantly different from those facing a similar project in the United States.[42] As a result, the project's cost of capital is affected by the location of the property[43] and, in certain circumstances, the investor.[44]

In order to account for the difference in the amount and sources of risks facing an international project, an international cost of capital should be calculated.[45] However, such investments are rarely financed locally or on their own, with the result that there is no universally accepted method for calculating a project's international cost of capital. The CAPM summarized above relies upon data from a functioning, diversified, long-

---

[42] *Id.* at 175 (providing this example but using a factory in Mexico and a U.S. investor as the example).

[43] *Id*. at 174 (explaining that risk would "differ significantly" if projects were located in different countries).

[44] *Id*. at 175 ("In calculating historical international risk premia, it is essential to keep in perspective the investor's location, because [it] is a crucial element in cost of capital analysis."). This is because an international investor's risk premium is affected by "exchange rate gains or losses." *Id*. The locale of the investor is thus important when currency risk is present but may not be important where currency risk is eliminated by the factual circumstances of the case, *e.g.,* the contract stipulates payment in the investor's domestic currency. *See id*. (providing an example of the different applicable risk premia for a Canadian investor investing in the U.S.). Currency risk, of course, is only one element of risk in international investments, and does not account for other components of political risk. *See* discussion of *Himpurna, infra § III.c.*

[45] *See id*. at 174-75; BREALEY & MYERS, *supra* note 2, at 198-201.

established equities market to act as a baseline in order to estimate the rate of return that the market would require from an asset given its riskiness.[46] In many, if not most, international arbitrations, the properties or investments at issue will be located in countries without a functioning, diversified equities market.[47] Even if the property is located in a country that currently has such a market, it is unlikely that the market will have been in existence long enough to produce sufficient historical data to generate statistically reliable conclusions using the CAPM in the manner described above.[48]

Although there is no single generally accepted method for calculating the cost of capital for international projects, there are a number of models that can be used to calculate a country-specific cost of equity, generally in the form of factors to be added to the WACC-based discount rate.[49] These models vary significantly in methodology and source data.[50] Each has its advantages and disadvantages. The choice and implementation of methods involves judgment as to which reasonable minds can disagree. The effect of applying such an adjustment is to take account of the level of

---

[46] Ibbotson notes that "[o]ne problem with market-based models is that they can only be applied to market-based economies. In a worldwide context there are few countries that have the data necessary to provide a CAPM cost of equity." IBBOTSON ASSOCIATES, INC., *supra* note 31, at 180. Foreign markets commonly have less data over shorter time periods, are less diversified, and are more concentrated. *See id*. at 175-76; *see also* BREALEY & MYERS, *supra* note 2, at 200-01 (stating that the lack of diversification leads to a lack of integration in the world market and necessitates adjustment to the basic CAPM) .

[47] *See supra* note 44.

[48] IBBOTSON ASSOCIATES, INC., *supra* note 31, at 175-76.

[49] *See id*. at 177 (stating that "[t]he measurement of cost of equity estimates for international markets is a developing area of academia").

[50] Ibbotson summarizes five such models in one of its recent texts: the International CAPM, Globally Nested CAPM, Country Risk Rating Model, Country-Spread Model, and Relative Standard Deviation Model. *Id*. at 177-84. While describing each of these models is beyond the scope of this endeavor, Ibbotson notes that the Country Risk Rating Model "offers a number of advantages that the other international models are unable to overcome." *Id*. at 183, *but see* BREALEY & MYERS, *supra* note 2, at 199-201 (proposing yet another method). The Country Risk Rating Model integrates biannual country credit risk ratings from *The Institutional Investor* to predict required rates of return. IBBOTSON ASSOCIATES, INC., *supra* note 31, at 180-81. Ibbotson also notes however that "all the models have some flaws" but "for most countries there is at least one model that produces a reasonable cost of equity estimate." *Id*. at 184.

systematic risk applicable in the country, market or region from which the measure is derived. There remains the need to adjust projected cash flows for any remaining idiosyncratic risk unique to the project. Nevertheless, the use of such an adjustment provides a method employing whatever objectively available data are available to approximate the applicable risk from sources not originating with the disputing parties so as to provide reasonably objective data points for assessing the effects of risk on value.[51]

> 4.   *Caveat: The Divergence of the Value of the Project Standing Alone from Its Value as a Component of the Claimant's Diversified Portfolio.*

As discussed above, the CAPM produces a discount rate based on WACC, which reflects only systematic, non-diversifiable market risk, which does not account for all of the risk peculiar to the individual investment. That method follows from the Modern Portfolio Theory, based on the observation that, in a diversified portfolio, idiosyncratic risk of one project is offset by others that vary in value independently. This is the measure of value of the project to the investor, the holder of the diversified portfolio. Using a different, higher discount rate to reflect the non-systematic risk of the lost project standing alone will result in assignment of a different, lower value, reflecting the best judgment possible of the risks peculiar to that asset. But this raises an important question: does the objective of restoring the investor to the position it occupied before the wrong require compensation at the value to the investor, that is, value measured in the context of a diversified portfolio? Or is the measure satisfied more precisely in restoring the standalone value, enabling the investor to re-invest the proceeds in an at least theoretically comparable investment and thus make its portfolio whole?

---

[51] BREALEY & MYERS, *supra* note 2, at 198-201 (stating that the "opportunity cost of capital for foreign projects should depend on market risk" and providing some discussion with a suggested method for calculating the applicable discount rate); *see also supra* notes 41-42.

The latter would seem to be the only correct answer, since to value the lost property without taking into account all of the risks affecting the chances of realizing all of the revenues projected, including most particularly the idiosyncratic, non-systematic risks, would seem inevitably to result in over-compensation, allowing the investor to improve, rather than merely restore, its prior position. Moreover, considering values different from the standalone value of the property determined in light of all of its risks would introduce the potential of recognizing different values to different claimants, a result that seems intuitively unacceptable. It would seem that putting the investor in the position to acquire an equivalent replacement investment would suffice to restore it to its position before the wrong. Nevertheless, the divergence of this model from the valuation process of the Modern Portfolio Theory warrants consideration, and the doctrinal basis for the appropriate process requires authoritative resolution.

E.   **Accounting for Non-Systematic Risk**

With engineering and geological risk accounted for in the reserve estimate and systematic industry and market risk addressed through the WACC and adjusted for regional or country risk, it remains necessary to account for non-systematic risk particular to the individual property being valued. The project may depend, for example, on the completion of processing or transportation facilities whose financing, construction or timing are uncertain, or on the satisfactory conclusion of regional arrangements necessary to realize the projected revenues. One need only consider the gas stranded in Alaska's North Slope fields for lack of pipeline transportation to market to appreciate the extreme case of the impact of uncertainty on value from particular local conditions. For such uncertainties, economic theory offers no ready formula. Unlike the lottery example above, it is not possible to count the number of outstanding tickets in order to compute

22

the probability of success of any one. Indeed, it may not even be possible to enumerate with certainty all of the possibilities that might cause revenues to fall short of the projections, much less when cash flow would be affected or in what amount, or whether the effects would be temporary or permanent. The line of demarcation between systematic risks encompassed in market value and non-systematic risk particular to the individual investment will not necessarily be clear and may involve differences in quantity rather than kind. And the further into the future the projection reaches, the greater the uncertainty.

Although there is no formula for such adjustments, there are objective benchmarks. For example, the incremental risk of damage to a vacation property from storms and flooding on hurricane-prone Cape Hatteras can be measured by the cost of storm and flood insurance. Including that cost in the projection of cash flows thus adjusts for that risk. All-inclusive insurance for the entire value of an investment over the property's economic life is, however, usually unavailable for projects as large as oil and gas investments. The impact of timing considerations on value can be modeled, as can the potential for unexpected increases in transit fees and taxes. Moreover, individual companies seeking international projects have proprietary and highly confidential models for quantifying such risk assessments in making their own investments.

There is considerable literature on the subject of modeling risk and uncertainty in business decision-making and valuation.[52] Sensitivity analyses comparing the relative impacts of changes in assumptions can assist in identifying the most important variables. "Monte Carlo" simulations can provide a systematic approach to estimating cash flows in

---

[52] A few such publications include BREALEY & MYERS, *supra* note 2; JEAN-PAUL CHAVAS, RISK ANALYSIS IN THEORY AND PRACTICE (2004); JOHNATHAN MUN, APPLIED RISK ANALYSIS: MOVING BEYOND UNCERTAINTY IN BUSINESS (2004).

the face of uncertainty.[53] This requires that the model include all of the variables that might impact the projected cash flow, the range of potential values of those variables, and the distribution of probabilities of those values within the given ranges.[54] The simulation creates a distribution of potential cash flow outcomes by running thousands of iterations with the variables allowed to vary within assigned ranges in accordance with probability distributions prescribed for each.[55] The result is an estimate of the range of future cash flows from the project together with the distribution of probabilities of outcomes within the range,[56] which can then be converted into the expected value of cash flows.[57]

---

[53] BREALEY & MYERS, *supra* note 2, at 232. Brealey and Myers emphasize the use of Monte Carlo simulations to estimate cash flow and caution against using the method to estimate net present value directly. *See id*. at 238-39.

The Asian Development Bank's Handbook for Integrating Risk Analysis in the Economic Analysis of Projects, on the other hand, departs from this usage by suggesting the use of Monte Carlo simulation to estimate net present value directly:

> The process which is followed (and which is usually referred to as "Monte Carlo" or simulation analysis) is that values for individual variables are generated randomly according to their respective probability distributions, combined with other randomly generated values for the other variables, and these figures are used to calculate an estimate of the project NPV. This process is repeated a large number of times (a number which is specified by the analyst—in effect, equivalent to implementing the project again and again in different circumstances—and is usually at least 1000 times, and typically more than this) and an average (or "expected") NPV is produced together with an associated probability distribution.

ASIAN DEVELOPMENT BANK, HANDBOOK FOR INTEGRATING RISK ANALYSIS IN THE ECONOMIC ANALYSIS OF PROJECTS, Ch. 2 at 18, *available at* http://www.adb.org/Documents/Handbooks/Integrating_Risk_Analysis/default.asp (last visited June 6, 2007).

[54] BREALEY & MYERS, *supra* note 2, at 232-35. Brealey and Myers provide an example of this process. Consider a business selling scooters that wants to project its future cash flows. The market size for scooters is a relevant variable. The owner anticipates that the market size will be one million scooters. However, the market size could be as low as 850,000 or as high as 1.15 million. The forecast error will therefore have an expected value of 0 (the owner does not expect that the forecast of one million scooters is wrong) with a range of plus or minus 15 percent. *Id*. at 234. Depending on the particular project and variable, the likelihood of error in a particular variable can be distributed in any manner necessary to properly replicate its perceived probability distribution. *Id*. at n.10.

[55] *Id*. at 235 ("After many iterations, you begin to get accurate estimates of the probability distributions of the project cash flows . . . .")

[56] *See id*. at 202-03 (stating that Monte Carlo simulations produce probability distributions for cash flows).

[57] *See id*. at 235 (stating that an unbiased cash flow forecast is derived from the probability-weighted cash flows by aggregating the products of each potential outcome multiplied by the probability of its occurrence); IBBOTSON ASSOCIATES, INC., *supra* note 31, at 16 (same).

The problem with Monte Carlo simulations, however, is anticipating and quantifying the sources of risk, the potential timing and magnitude of any impact on cash flows and the probability of such risks manifesting themselves in any given time period. The necessary data may be insufficient or unavailable.[58] The process also necessarily entails subjective judgment, such as which variables should be included and estimating error forecasts for each included variable.[59] As Professors Brealey and Myers note, a Monte Carlo simulation follows the "garbage in, garbage out" rule and is only accurate "to the extent that [the] model and the probability distributions of the forecast errors are accurate."[60]

While the accuracy of this or any estimate of future events is unavoidably subject to judgment and dispute, Monte Carlo simulations provide a transparent structure for combining the effects of multiple sources of uncertainty and testing the assumptions underlying the resulting conclusions. Such transparency permits reasoned analysis, advocacy and awards on a factor of critical importance to the outcomes of particular disputes.

F. Adjustments to the Discount Rate

A common method for accounting for non-systematic project risks is to adjust the applicable discount rate by reference to returns on other investments deemed to be of analogous risk. Accounting for non-systematic risk in the applicable discount rate is emphatically rejected by economic and financial theory. Conceptually, it should be possible to reach the same result by adjusting either the discount rate or the cash flows.

---

[58] *See* ASIAN DEVELOPMENT BANK, *supra* note 53, at Ch. 2, at 19-21.

[59] *Id*. at Ch. 2, at 20-21 (stating that error forecasts for variables "still require judgment on the part of the analyst about what ranges are acceptable for values to fall within.").

[60] BREALEY & MYERS, *supra* note 2, at 235.

Professors Brealey and Myers suggest that there is little point in the exercise to the extent that deriving the rate requires estimating cash flows in order to verify the equivalence.[61] On the other hand, if reasonably comparable analogs are available, the difficulty and subjectivity inherent in adjusting cash flows could make use of a discount rate derived from comparable investments practical and, for that reason, attractive. This method enjoys the advantage of deriving a single adjustment from market data judged to be comparable rather than attempting to derive a series of discrete adjustments to each term's cash flow projection that must quantify risks applicable to the individual property as differentiated from those applicable to the market generally.[62] The method assumes the ability to find or construct investments with analogous risk, a process that in itself involves considerable judgment and therefore room for reasoned disagreement. On the other hand, the method avoids the risk of over- or under-compensating due to the risk of double-counting elements of risk between the adjustments to cash flows and the discount rate. While this method is clearly not accepted in theory, and its use risks substantial criticism from that perspective, its use is common and it may offer useful benchmarks by which to check conclusions reached using a more theoretically orthodox approach**.**

---

[61] *Id.* at 202.

[62] *Cf.* J.B. Gustavson, *Valuation of Non-U.S. Oil and Gas Properties*, J. PETROLEUM TECH., Feb. 2000, at 56 (noting that other researchers have found that there is a "6 to 8% excess of the average market discount rate over the average cost of capital" and that the excess is "sometimes considered . . . [as] offsetting the 'risk' of the oil business.") (citation omitted). It is not clear whether the article is suggesting that the market is including some form of specific risk into the discount rate or if it is merely suggesting that the average cost of capital does not properly assess the amount of systematic risk that the market attributes to the oil business, which is unsurprising given that the systematic risk facing a foreign oil field will generally be greater than that faced by the company as a whole.

G. Industry Practice.

Given that determination of net present value unavoidably involves the prediction of uncertain future events, it is hardly surprising that the process entails elements of judgment and subjectivity. Nevertheless, tools for the refinement of the process are used daily in the oil and gas industry and in financial and investment analysis generally. These tools could be expected to serve to increase the transparency of decision-making with respect to the computation of damages, afford greater predictability to the outcome of disputes facilitating dispute settlement and reduce the risk of challenges to awards based on failure to explain the reasoning behind the determination of damages.

However, industry practices are highly proprietary and neither publicly accessible nor readily available for disclosure even in confidential proceedings. Moreover, what information is available indicates that practices vary greatly. A yearly survey conducted by the Society of Petroleum Evaluation Engineers reveals that, although 90% of the respondents (primarily producers, consultants and bankers) use the DCF methodology, they differ considerably in whether they discount for risk at all, whether they adjust for risk exclusively through discounting or account for reserve risk separately, and how they determine and apply discount rates.[63] Some respondents use a discount rate that is only equal to their cost of capital, while others calculate discount rates that aggregate their cost of capital with additional risk premiums, with rates ranging from 0 to 33%. Respondents

---

[63] *See* SOCIETY OF PETROLEUM EVALUATION ENGINEERS, TWENTY-FIFTH ANNUAL SOCIETY OF PETROLEUM EVALUATION ENGINEERS SURVEY OF ECONOMIC PARAMETERS USED IN PROPERTY EVALUATION 14 (June 2006).

report basing rates on sources ranging from "judgment" to cost of capital to the results of SPEE surveys.[64]

Such variety undoubtedly reflects to some extent the variety of circumstances faced by the industry. In addition, it no doubt explains in part the absence of a consistent approach to accounting for risk in reported decisions on valuation.

III.   THE DCF METHOD AS APPLIED IN REPORTED DECISIONS

The lack of clear definition of the governing principles and methods for accounting for the specific risk of individual assets is evident in the relatively few cases that have addressed the issue. The initial, ground-breaking awards that overcame the historical resistance to "speculation" in projections of future revenues, struggled to find an appropriate methodology for addressing uncertainty and in the end candidly acknowledged reaching conclusions with no pretense of systematic calculation, based on the tribunals' analyses of the facts and arguments presented and evaluation of the appropriate results, in light of what they deem equitable in the circumstances. Two more recent decisions apply the DCF method using a discount rate based on the WACC of the investment without discussion, apparently reflecting agreement between the experts as to the method, and focus on disagreement as to the application of the DCF, principally on the details of projected cash flows. Thus they do not explore the relevant principles applicable in the absence of such agreement.

---

[64] *See id.* at 16-23.

Without criticizing these results in any way, it is apparent that the approach of the earlier cases left the parties to the immediate disputes with no means of understanding or assessing the specifics of the reasoning leading to the quantum. While these decisions marked important steps forward from the earlier limitation to historical costs, the absence of more specific discussion of the means used to address the unavoidable uncertainty in predicting the future afforded very little guidance to future parties, advocates and tribunals on the proper determination of damages. As a result, the outcome of future disputes remained less predictable, more difficult to settle and more expensive to arbitrate, as each dispute grappled anew with the most appropriate methodology for accounting for risk.

The two more recent cases, *ADC Affiliate* and *Sempra*, discussed below, conform to economic theory without discussing it. In particular, the decision in *Sempra Energy International v. Argentine Republic*[65] contains the most complete discussion of the DCF method's application and lays out the tribunal's analysis in determining the applicable discount rate and adjustments to certain elements of the projected cash flow. In the process, the tribunal provides a transparent record of the figures used in calculating damages, without necessarily providing detailed explanation of their calculation. Nevertheless, the tribunal's detailed discussion of its application of the DCF is consistent with economic theory and provides a framework that may be useful in future proceedings. Given the magnitude of the potential impact of uncertainty on the size of an award, failure to provide more specific explanation of how the quantum is derived is likely to be the subject of post-award challenges for failure to give reasons for the amount

---

[65] ICSID Case No. Arb/02/16, Award of 28 September 2007, *available at* http://www.investmentclaims.com/decisions/Sempra_Energy-Award.pdf (last visited November 12, 2007).

of the award.[66] All of these considerations strongly suggest that further progress toward making the principles underlying these adjustments as well as their specific applications more transparent and systematic would be of substantial value to individual outcomes and to the arbitral process.

A.   *Starrett Housing*

If nothing else, the decision on damages in *Starrett Housing Corp. v. Iran* ("*Starrett Housing*")[67] illustrates dramatically the importance of adjustments for uncertainty in determining value using discounted cash flow: the tribunal reduced its own expert's calculation of the net revenue of the project company at issue by some 90%.[68] In broad scope, the methodology recommended by the tribunal's expert and largely accepted by the parties and the tribunal itself generally conformed to the mandates of economic and financial theory as outlined above. In particular, the award adopted the fair market value standard[69] and reflects painstaking efforts to adjust expected cash flows to account for various elements of risk and uncertainty. However, in important ways the procedures employed in *Starrett Housing* departed from accepted methodology, which

---

[66] Such a challenge may be no more likely to succeed than any other. *See Bridas S.A.P.I.C. v. Gov't of Turkmenistan*, 345 F.3d 347 (5th Cir. 2003) (refusing to vacate award of damages based on discounting projected revenues from Central Asian gas properties at 10% based on contractual interest rate for carried interest with an estimated upward impact of $200 million on the award, noting discount rate is a matter of fact for determination by the arbitrators). (Messrs. Knull and Tyler were counsel to the Turkmenian party.)

[67] *Starrett Housing Corp. et al. v. Iran*, Award No. ITL-314-24-1 (14 Aug. 1987), *reprinted in* 16 IRAN-US C.T.R. 112 (1988).

[68] *Id.* ¶¶ 342, 337 (reducing gross profit from 377 million Rials by 350 million Rials, to 27 million). Although the tribunal used the term "gross profit," the context makes clear that the numbers cited are based on analysis of revenues net of costs and do not purport to relate to the accounting concept of profits.

[69] *Id.* ¶ 277.

only increased the difficulty of assessing the impact of subjective factors on the very large swing in resulting values.[70]

One striking departure from economic theory in *Starrett Housing* was the derivation of the discount rate. The tribunal's expert recommended, and the tribunal accepted, a rate based on "a return on capital expected by a reasonable businessman on [the date of expropriation] as well as on the expected rate of inflation, rate of real interest, and rate of risk."[71] Real interest rates at the time were said to have been negative.[72] Without explaining the source of the number, the expert recommended and the tribunal accepted a rate of 11% to encompass both the real rate of interest and risk. According to the expert, the only risk accounted for by this number was the risk of error in the calculation of net revenues, as remaining components of risk were addressed in the projected cash flows.[73] To this 11%, the expert recommended, and the tribunal again accepted, the addition of 17%, derived from the Iranian consumer price index to account for inflation, for a total discount rate of 28%.[74]

The expert's reference, adopted by the tribunal, to fixing the discount rate at the "return on capital expected by a reasonable businessman on [the date of expropriation] as well as on the expected rate of inflation, rate of real interest, and rate of risk" sounds more or less plausibly like the concept of the opportunity cost of capital endorsed by

---

[70] The award in *Starrett Housing* was signed by only two of the three arbitrators, the Iranian nominee having refused to join. In a concurring opinion, the nominee of the United States party, Howard Holtzmann, indicated that he signed only in order to ensure that an award was issued, despite his disagreement with certain of the key determinations. Because Judge Holzmann's disagreement largely flowed from conclusions he would have drawn from respondents' failure to produce relevant evidence rather than on the methodology under discussion here, we will not address it further.

[71] *Id.* ¶ 32.

[72] *Id.* ¶ 196.

[73] *Id.*

[74] *Id.* ¶¶ 196-97.

economic theory. However, the derivation of the actual number used bears no resemblance to the determination of the weighted average cost of capital by reference to the project's cost of equity and debt, as described above. As a result, while the objective may have been to determine the return that a reasonable purchaser would have required, the rate does not purport to derive that number directly from observed market data. Inflation in consumer pricing undoubtedly affected the risk-free discount rate, but does not measure it directly. Nor does inflation reflect the systematic, non-diversifiable market risks to the project owner of operating the particular business. Moreover, the risk component of the computation was neither defined nor quantified, as the award reports only the sum of this component and the negative real rate of interest. As a result, it is impossible to assess the sufficiency of this component to address the risk of error in the computation of revenues or to verify that the only risk this component addressed was the risk of computational error. Consequently, although the discount rate was supported by reference to external data, the expert's selection of reference points on which to base the rate did not conform to economic theory and the resulting rate cannot be confirmed as appropriate to convert projected revenues to present value. Moreover, the tribunal's deference on the issue was based on trust in its expert rather than compliance of the expert's recommendation with theory or appropriate objective standard.

The parties, experts and tribunal in *Starrett Housing* did agree on the necessity of adjusting cash flows to reflect uncertainty. The award provides elaborate detail as to the deliberations on each of the components of the revenue computations. Whereas the tribunal deferred to its expert with respect to the selection of the discount rate on the grounds that that determination was within his technical expertise and no persuasive

32

reason had been offered to reject it,[75] the arbitrators concluded that they could evaluate the issues affecting components of cash flow just as a hypothetical reasonable businessman contemplating purchase of the project would, and on that basis departed from the expert's recommendations where they thought that was warranted.[76] As the tribunal noted, these adjustments were entirely fact specific and not subject to expert technique. On the other hand, Judge Holzmann's concurring opinion argued that respondents' refusal to produce documents relevant to several of these components raised issues about the conclusions reached and, arguably, serious questions about the risk of error in the computation of revenues, whose quantification cannot be verified given the derivation of the discount rate noted above.

In the end, however, the precise impact of the tribunal's findings on individual elements of the valuation cannot be ascertained. Despite the existence of an agreed methodology for valuing the lost project, the tribunal elected to announce its conclusion without explaining how it was derived:

> These matters are not capable of precise quantification because they depend on the exercise of judgmental factors that are better expressed in approximations or ranges. In these circumstances, the Tribunal must make an overall determination of a global amount, taking account of the nature of the forecasts involved and the various interrelationships between them. This is, indeed, what reasonable businessmen typically do when finally determining the price they are willing to pay in a complex transaction. Therefore, the Tribunal again steps into the shoes of the hypothetical reasonable businessman, and will consider what he would have done, faced with inevitable uncertainties yet wanting to conclude a purchase.[77]

---

[75] *Id.* ¶ 336.

[76] *Id.* ¶ 274.

[77] *Id.* ¶ 338.

Of course the ability, if not the obligation, of arbitrators to render their awards in light of all of the circumstances, factual, legal and equitable, means that they are not constrained to follow any particular legal or economic theory. But where, as here, the effect of their analysis is to reduce a claim by 90%, the consequence of resorting to a black-box calculation is to deprive the parties of a clear understanding of how the result was reached, leaving future parties, advocates and arbitrators to reinvent the process in subsequent disputes and ultimately risk challenge to an award for failing to discharge the arbitrators' obligation to explain their results.

B.   *Phillips Petroleum*

The award in *Phillips Petroleum Co. Iran v. Iran* ("*Phillips*")[78] accepted DCF calculations as "evidence the Tribunal is justified in considering in reaching its decision on value," since "a prospective buyer of the asset would almost certainly undertake such DCF analysis to help it determine the price it would be willing to pay," although it was "not an exclusive method of analysis." [79] Having accepted the method, however, the tribunal concluded that the claimant's estimates of production and prices and low 4.5% discount rate failed to take into account risks, such as the risk of reduced future production as a result of national policy changes flowing from the Iranian Revolution, that should be taken into account, even if they could not be quantified with certainty in either the revenue projections or the discount rate. As a result, the tribunal considered claimant's DCF model as evidence of value at the date of taking to be considered along with all relevant circumstances, but declined to "make its own DCF analysis with revised components," and elected instead to "determine and identify the extent to which it agrees

---

[78] Award No. 425-39-2 (29 June 1989), *reprinted in* 21 IRAN-U.S. C.T.R. 79 (1989).

[79] *Id.* ¶¶ 112-13.

or disagrees with the estimates of both Parties and their experts concerning all of these elements of valuation."[80] The result, while acknowledging the utility of the DCF method, was to leave the process of adjusting the results of the DCF calculation for the risks perceived by the tribunal without explanation.

At issue was Phillips Petroleum's 1/6 interest in a long-term Iranian oil venture.[81] The tribunal found that Iran had expropriated Phillips Petroleum's interest by terminating a joint operating agreement.[82] The *Phillips* tribunal ruled that Phillips Petroleum was due "just compensation" equal to the "full equivalent of the property taken," noting that the governing treaty required award of "compensation that makes the Claimant whole for the 'fair market value' of the property at the date of taking," that is "what a willing buyer and a willing seller would reasonably have agreed on as a fair price at the time of the taking in the absence of coercion on either party."[83]

The tribunal separated the issues necessary to the valuation broadly into calculation of the anticipated quantity of oil recoverable,[84] the anticipated price of oil,[85] the anticipated production costs,[86] and the associated risks.[87] In addressing the quantity of oil, the tribunal separated consideration of how much oil was recoverable assuming the will to produce it, from the "analytically quite separate" question of the readiness of the

---

[80] *Id.* ¶¶ 113-14.

[81] *Id.* ¶¶ 3, 29.

[82] *Id.* ¶¶ 100-01.

[83] *Id.* ¶ 106.

[84] *Id.* ¶¶ 117-24.

[85] *Id.* ¶¶ 125-31.

[86] *Id.* ¶¶ 132-34.

[87] *Id.* ¶¶ 135-53.

parties to produce the oil, including making the investments necessary to achieve that

level of production:

> The Tribunal thinks it preferable to examine first the question of the
> quantity of oil in place that could reasonably have been expected . . . to be
> recoverable . . . as a technical matter, given the will both to make the
> necessary investments to that end and to lift all the available oil.   The
> Tribunal will then deal separately and as part of the analysis of the
> perceived risks with the question of the extent to which a buyer . . . should
> reasonably have anticipated that future investment and production might
> fall short of that maximum level.[88]

Observing that the ultimate recovery can only be known after the last barrel has

been produced, the tribunal noted that "competent and conscientious experts will almost

invariably disagree within a range," and proceeded to make findings on the range of oil

recoverable.

The tribunal adopted a similar approach with respect to price.   The parties

presented conflicting evidence, including various predictions of prices increasing from

the already high levels of 1979 and skepticism concerning such scenarios. Observing that

"September 1979 was a time when the always uncertain business of forecasting future

crude oil prices was even more difficult than usual," the tribunal concluded that a

reasonable purchaser of Phillips' interest would have anticipated a range of prices

bounded by the forecasts by each party[89] and specifically in the lower segment of the

range.[90]   The tribunal then reserved consideration of "the risk that world oil prices . . .

would prove to fall outside that foreseeable range"[91] before ultimately concluding that

---

[88] *Id.* ¶ 118.

[89] *Id.* ¶ 129.

[90] *Id.* ¶ 131.

[91] *Id.* ¶ 125.

downside price risk was offset by the potential for price increases, such that no further

adjustment was needed.[92]

The tribunal did not discuss risk in connection with production costs. Instead, it

concluded that "the [c]laimant's estimates of future costs . . . are substantially too low,

perhaps by as much as 50 to 75 percent," but that costs had only a "very minor effect" on

the total value of claimant's interest to the extent of 2 to 3 percent of value.[93]

In all of these discussions, the tribunal refrained from reaching – or at least

disclosing – quantitative conclusions on the cash flows resulting from their adjustments

to the projections submitted by the parties. The result is a purely notional expression of

the tribunal's conclusions, consistent with its commitment "to determine and identify the

extent to which it agrees or disagrees with the estimates of both Parties and their experts

concerning all of these elements of valuation."[94]

Having thus addressed the principal components of cash flow, the tribunal

considered the risks that could have been "perceived . . . by any buyer of [the claimant's]

interests as affecting their revenue-producing potential,"[95] observing that

> It seems certain that any reasonable buyer would have analyzed the
> relevant risks as carefully as he would have analyzed those other three
> factors in deciding what price he would have been prepared to pay for the
> Claimant's JSA interests. Nevertheless, it is well established that the
> Tribunal must exclude from its calculation of compensation any
> diminution of value resulting from the taking of the Claimant's property or

---

[92] Because it was deciding on the fair market value of the interest at the time of taking, the tribunal based its conclusion on the price expectations prevailing at that time, noting that "[h]istory, to date, has shown that the price expectations generally held in 1979 were grossly inflated, but that does not make it wrong or unfair to use those expected price levels in the determination of the value of the property in 1979. A state that takes property assumes the risk of its subsequent decline in value, just as it assumes the benefits if the value appreciates." *Id.* ¶ 126.

[93] *Id.* ¶ 134.

[94] *Id.* ¶ 114.

[95] *Id.* ¶ 135.

from any prior threats or actions by the Respondents related thereto. . . . On the other hand, with these exceptions, the Tribunal would not be warranted in ignoring the effects on the value of the property of the Iranian Revolution as they would have been perceived by a reasonable buyer in September 1979.[96]

The tribunal's starting point in accounting for risk was the testimony of Professor Stewart Myers, co-author of a leading treatise on finance cited elsewhere in this article.[97] In brief, Professor Myers calculated the weighted average cost of capital of a sample of large oil companies at 4.5%. Professor Myers opined that the high risks associated with interests in oil reserves in politically unstable areas to a large extent reflect the possibility of expropriation, which he understood was to be excluded from this calculation. Other risks and uncertainties to the components of the DCF calculation he said should be accounted for in the respective forecasts, which the claimant purported to have done.[98]

In reviewing the claimant's DCF analysis and Professor Myers' calculations, the tribunal decided that "[s]ince the Tribunal has decided to refrain from performing an alternative DCF calculation . . ., it does not substitute the Claimant's discount rate with its own, but rather identifies which risks are relevant to such an analysis and determines their approximate effect on the value of the [c]laimant's . . . interests."[99] The tribunal found that two such risks had not been adequately accounted for in the claimant's discounted cash flow analysis.[100] Specifically, the tribunal concluded that

---

[96] *Id.* (citations omitted).

[97] *Id*. ¶¶ 136-38.

[98] *Id*. ¶ 136.

[99] *Id*. ¶ 138.

[100] *Id.* ¶¶ 141-53. As to the risk of oil price fluctuations, the tribunal concluded that "that the possibility of prices lower than the bottom range could then have been seen as no more likely than the offsetting possibility of prices higher than the top of the range, and that therefore, based only on the information available at that time, no further reduction of the price would have been warranted by virtue of such a risk." *Id*. ¶ 150.

- the value of the Claimant's JSA interests in September 1979 would have been reduced substantially by virtue of the perceived risks that Iranian or OPEC policies and NIOC priorities and financial and production limitations might prevent recovery of some of the oil that otherwise could be recovered;[101] and

- the value of the Claimant's JSA interests in September 1979 would have been reduced very significantly by virtue of the perceived risk that a buyer might encounter irresistible future pressures to modify the JSA in ways that would greatly reduce the anticipated future profitability of those JSA interests.[102]

As a result, the tribunal did not accept the claimant's discount rate or cash flow projections.[103] Instead, it found that "a buyer of the [c]laimant's . . . interests in September 1979 would reasonably have seen the risks as much higher than the Claimant has assumed."[104] As the tribunal explained,

> With respect to risks, the Tribunal has concluded that a buyer of the Claimant's JSA interests in September 1979 would reasonably have seen the risks as much higher than the Claimant has assumed. The Claimant assumed that the risks were no higher than for any other investment by a major oil company, and it therefore used a discount rate (4.5 percent) identical to its calculations of the real cost of capital to such companies. The Tribunal has concluded, however, that the risks that would reasonably have been perceived in 1979 would have reduced the value of the Claimant's JSA interests very substantially.[105]

The tribunal did not, however, explain how the claimant's DCF analysis should have incorporated these risks nor did it set out its ultimate calculation of the quantum of the award. Without further analysis, the tribunal awarded the claimant US$55 million, against a claim of US$159 million, after "taking into account all relevant

---

[101] *Id.* ¶ 148. On the other hand the tribunal concluded that non-policy risks such as the risks of delays or interruptions of production as a result of force majeure, such as war, further civil unrest or strikes by the labor force would not have had a significant impact on total production, while longer term interruptions, specifically the Iran-Iraq war that began in 1980, was not apparent at the time of the taking. *Id.* ¶ 149.

[102] *Id.* ¶ 153.

[103] *Id.* ¶ 155.

[104] *Id.*

[105] *Id.*

circumstances."[106] Thus, while the decision is clear as to which risks the tribunal considered to be relevant to value and the importance of those risks to the ultimate value awarded, it provides no benchmark for the parties or for subsequent parties, advocates and arbitrators with respect to the proper method for accounting for such risks.

C.   *Himpurna*

Although the decision in *Himpurna California Energy Ltd. v. PT. (Persero) Perusahaan Listruik Negara (Himpurna)*[107] adopts the DCF method and addresses adjustment for risks in a variety of ways, its explicit reliance on equitable factors, joined with its equally explicit omission of explanation of its calculation of quantum, provides little enlightenment on the proper method for risk adjustment under different circumstances. *Himpurna* involved claims arising out of a project for the use of geothermal energy to generate electricity that the Indonesian state electricity corporation had agreed to take or pay for.[108] The tribunal noted that the breach had not been intended by the respondent to deprive claimant of a thriving business; instead, the breach resulted from macroeconomic factors from which the respondent "has suffered helplessly," having "accepted the entire market risk."[109] The claims arose two years into the thirty year contract, after substantial investment by the claimant[110] but before delivery of any energy.[111] Claimant sought to recover its entire expected net revenues over the life of the

---

[106] *Id*. ¶ 158. While it did not disclose the calculation underlying its quantum, the tribunal addressed with considerable specificity its calculation that updated book value tended to confirm its overall valuation. *Id.* ¶¶ 159-65.

[107] Award of 4 May 1999, *reprinted in* XXV Y. B. COMM. ARB.13 (2000).

[108] *Id*. ¶ 1.

[109] *Id.* ¶ 332.

[110] *Id*. ¶ 347 (stating that the claimants had incurred costs of US $273,757,306 which was calculated using a multiplier to bring the previously paid costs to present value).

[111] *Id*. ¶ 365.

project, even though barely a third of the investment needed to produce those revenues had been made and recovery of the full amount claimed would have yielded a return of some 630% over the amount invested.[112]

In the first instance, the tribunal applied these equitable considerations explicitly to its damage calculation. First, it explained that, although as a matter of probability it "would likely prefer" claimant's estimate of the likely output of the geothermal field, it would instead adopt "the lowest figures of all: those put forward by [respondent's] expert," choosing the resulting certainty – the elimination of uncertainty to that extent – in light of the equities of the circumstances giving rise to the claim.[113] Similarly, the tribunal elected to limit claimant's recovery to that proportion of net present value (36%) corresponding to the proportion of costs claimant had already incurred to those that claimant acknowledged it would have been required to invest to achieve those projected revenues.[114]

Having eliminated elements of risk from the cash flow projections by accepting the low-end estimate of production and limiting overall damages to the proportion of costs already expended, the tribunal focused its further discussion of risk on the discount rate. The tribunal observed that the rates submitted by both parties bore an "air of unreality . . . ."[115] In support of its proposed rate of 8.5%, including a 3% premium for risk, the tribunal stated that "the claimant seemed to ignore studiously that it had embarked on a venture in Indonesia"; similarly, in arguing for a rate of 33.7%, the

---

[112] *Id.* ¶ 318.

[113] *Id.* ¶ 313.

[114] *Id.* ¶ 347. In addition to the equitable considerations previously mentioned, the tribunal noted that claimant remained free to invest these amounts in other projects.

[115] *Id.* ¶ 353.

respondent ignored that it had "signed a firm undertaking to pay in US dollars."[116]

Second, the tribunal explained that the "factors that weigh[ed] heaviest in the minds of the arbitrators" were (1) the country risk, (2) performance risk associated with geothermal development, (3) the time-value of money, and (4) the internal rate of return of the claimant as calculated by the tribunal.[117]

Rejecting the rates offered by the parties, the tribunal applied a discount rate of 19%.[118] In so doing, they acknowledged that they

> make no pretence that this is the result of precise weighings of the discrete considerations that have influenced the arbitrators; nor do they wish to create the illusion that they have engaged in econometric modeling, or even calibrated costs and revenues with a time line that establishes hypotheses for the commissioning of generating Units, contingencies of "101" reservoir evolution, and the like. Both the rate and its application reflect a series of adjustments made by the arbitrators in their equitable assessment of the evidence, and, in the circumstances of this case, resolving all doubts in favour of PLN, the debtor.[119]

Given the equitable circumstances that weighed so heavily on the outcome of *Himpurna*, the decision's importance to future valuation issues lies primarily in its unapologetic adoption of the DCF method and in its explicit acknowledgement of its departures from strict principles of valuation in order to reach a result appropriate to the circumstances. In so doing, however, it did not address, perhaps because there was little point in doing so, the finer points of valuation in circumstances less laden with equitable

---

[116] *Id.* ¶ 355.

[117] *Id.* ¶¶ 364-70. Lesser factors included "disruption, for technical or other reasons, of the rate of installation of Units;– volcanic or hydrothermal eruptions;– technical disputes as to the application of the price formula (for example, reference to a Unit Rate Capacity test in the absence of an operational Mechanical Gas Extractor could exaggerate the URC and thus the price); and costs could be increased by, inter alia: – unanticipated expenditures on account of such problems as scaling due to the chemical composition of brine affecting the state of pipes, wells and turbine blades; or the need to drill more so-called make-up wells than anticipated in order to maintain the steamfield pressure;– insufficient clarity in the claimant's computations as to the breakdown of costs in rupiah as opposed to US dollars." *Id.* ¶ 362.

[118] *Id.* ¶¶ 363-71.

[119] *Id.* ¶ 371.

considerations. Indeed, the tribunal acknowledged that given its approach, one could object to its invocation of the DCF method as a "fig leaf," and averred its intention to be "transparent in both its reasoning and its computations."[120] Nevertheless, in the absence of the substantial equitable considerations that drove the decision in *Himpurna,* economic theory and sound business practice do provide more rigorous methods for addressing uncertainty, of which *Himpurna* provides only limited demonstration.

D. *ADC Affiliate*

ADC Affiliate Ltd. v. Hungary (ADC)[121] provides a straightforward application of the DCF model in the context of a regulated industry subject to no project risk. The tribunal readily accepted damages based on contractually determined cash flows discounted to present value at the project entity's weighted average cost of capital. Although the tribunal ultimately awarded an amount "with which it [was] comfortable in all the circumstances of the case,"[122] that amount was identical to the result of claimants' DCF analysis.[123]

The claims against Hungary were based on the loss of their investment interest in the renovation of the Budapest-Ferihegy International Airport, construction of an additional terminal for the airport, and their right to participate in the airport's ongoing operations.[124] The tribunal concluded that the claimants' investments had been taken in

---

[120] *Id.* ¶¶ 373-74.

[121] ICSID Case No. Arb/03/16, Award of 2 October 2006, *available at* http://www.worldbank.org/icsid/cases/pdf/ARB0316_ADCvHungary_AwardOctober2_2006.pdf (last visited June 6, 2007).

[122] *Id.* ¶ 521.

[123] *Id.* ¶¶ 519, 521.

[124] *Id*. ¶¶ 11, 109

violation of the treaty's provision against illegal expropriation.[125] As such, the claimants

were entitled to the "market value of the expropriated investments."[126]

In assessing market value, the tribunal found that the claimants' application of the

DCF methodology was "fully justified" and that their "approach and method [were]

reasonable and . . . reliable and . . . endorsed by the [t]ribunal."[127] In projecting the cash

flows for the project, the tribunal had no reason to review or discuss risk; the cash flows

for the project were in excess of the contractual limit upon the claimant's profits.   The

cash flow projection thus merely estimated that the profits would increase at the

contractual limit.[128]

The tribunal's brief discussion of the applicable discount rate was divided into

three distinct parts. First, the tribunal explicitly agreed with the claimants' discount rate

calculation, which was derived from data relating to "various representative airports, and

not just one."[129] Furthermore, the discount rate included an "adjustment for country

risk."[130] Second, the tribunal refused to increase the discount rate based upon the

respondent's contention that the claimants' investment should be subject to an illiquidity

and minority discount. The tribunal stated that such discounts are "usually associated

with privately held companies that have erratic or volatile cash flows. Regulated entities,

---

[125] *Id.* ¶ 476.

[126] *Id.* ¶ 499; *see also supra* note 4 (noting that the tribunal allowed the claimant to recover the market value of the investments as of the date of the award because the investments had increased in value since the time of the expropriation).

[127] *Id.* ¶ 514.

[128] *Id.* ¶¶ 508-09.

[129] *Id.* ¶ 511. The award does not specify exactly how the beta applied was derived from the betas of various airports or how the betas of the various airports used to derive the applied beta were calculated.

[130] *Id.* (noting that "the [r]espondent's contention that the country risk 'may be understated'" was short of any substantiation). The award did not explain how this country risk adjustment was calculated, but its inclusion is theoretically congruent with the adjustments mentioned *supra* in notes 40-50 and the accompanying text.

such as the [project company in which the claimants had an interest], do not typically attract an illiquidity discount because of the relatively stable cash flows associated with them."[131]   Likewise, the tribunal refused to apply a minority discount because the claimants "had adequate shareholder protections in the [p]roject [a]greements."[132]

While the circumstances of *ADC* will not often apply to investments in oil and gas projects in remote corners of the world, where project risk is an ever-present reality, the tribunal's analysis is fully consistent with economic theory in a context in which application of that theory was not obscured by the presence of overriding equitable considerations.

E.   *Sempra Energy v. Argentina*

Finally, the award in *Sempra Energy International v. Argentine Republic* ("*Sempra*")[133], applied a discount rate based on the cost of capital, rejected a proposed risk premium based on the country risk premium applied to Argentine bonds at the time of the crisis and otherwise accounted for risk by adjusting key elements of the projected cash flow. The tribunal initially rejected an alternative damage model offered by the respondent in favor of fair market value based on discounted cash flow,[134] citing to *Chorzow Factory* and to Article IV of the International Law Commission Articles on State Responsibility for Wrongful Acts.[135] Instead, the tribunal adopted the claimant's

---

[131] *Id.* ¶ 512.

[132] *Id.*

[133]   ICSID   Case   No.   Arb/02/16,   Award   of   28   September   2007,   *available   at* http://www.investmentclaims.com/decisions/Sempra_Energy-Award.pdf (last visited November 12, 2007).

[134]   *Id.* ¶¶ 407-15. The tribunal characterized Respondent's alternative model as designed to "judge whether the [distribution] companies have been fairly remunerated in the past" rather than "what they were worth in 2001 given their prospects over the remaining years of the licenses," noting that "International legal standards governing compensation do not normally consider past earnings to determine compensation due." *Id.* ¶ 413.

[135] *Id.* ¶¶ 400-01.

contention that the majority of its damages consisted of the difference between the value

of its investment given the measures imposed by Argentina and the value it would have

realized "but for" those measures. With apparent broad agreement among the experts

appointed by the parties and the tribunal on overall principles, the remaining differences

between the parties related to the particular facts of the case, rather than matters of more

fundamental principle. In resolving those differences, however, and in particular in

discussing their considerations in determining the applicable discount rate, the tribunal

laid out a clear and transparent record of the means by which they reached their

conclusions.

Sempra had invested in Argentine companies involved in the distribution of

natural gas. That sector itself implied some level of relative risk, as the tribunal noted

that the risk of retail customer payment default faced by distributors was likely to be

higher than the risk of distributor payment default faced by gas transportation

companies.[136] The parties largely agreed on the weighted cost of capital, which had been

a component of the regulatory system for the establishment of tariffs. Argentina relied on

the cost of equity that had been adopted by the Argentine regulatory authority,

ENARGAS, while the claimant submitted a somewhat higher number, yielding a slightly

higher WACC, which the tribunal accepted.[137]

In doing so, the tribunal rejected the suggestion that higher discount rates should

have been used "as a consequence of the premium on Government bonds being very high

at the end of December 2001 because those bonds were in default at that time and as a

---

[136] *Id.* ¶ 429.

[137] *Id.* ¶¶ 430-31. The higher discount rate, of course, led to a lower overall valuation. Because the cost of capital was apparently well defined in the Argentine market, the tribunal did not face many of the issues that arise in the absence of reliable reference data. *See* pp. 19-21, *supra.*

consequence they could only sell at a deep discount."[138] The tribunal noted that "the

country risk premium required by an investor in a private company in Argentina was

significantly lower than the Government's credit risk premium during the same period,"

and even more so in the case of companies in regulated industries like the distribution of

electricity.[139] Thus the tribunal concluded, as a matter of fact, that the country risk

premium applicable to Argentine bonds was not an appropriate measure of the risk of

private, regulated companies.

In addition, the tribunal noted that if the regulatory framework of the investments

had been maintained, the impact of the crisis on the distribution companies would not

have been as strong as that on government bonds, especially over the long term of the

investment. This led the tribunal to a series of conclusions.

- First, the rate applicable to the distribution companies should be lower than that
  applied to government bonds.[140]

- Second, the high level of risk pertaining during the crisis should not be expected
  to have persisted for the entire the period of the licenses, making it inappropriate
  to apply a discount rate based on premiums observed at the height of the crisis
  throughout the remaining 25 years of the investment.[141]

- Third, the fact that sale of the shares at the height of the crisis might have resulted
  in "adverse reactions engendered by the state of economic and political
  difficulties," was not controlling, since Sempra had invested for the long term and
  not for trading purposes, so that "an unusually high market discount should not be
  included in the valuation of a long term investment, on the basis of a serious but
  temporary economic crisis."[142]

- Finally, it was nevertheless necessary to take into account the impact of the crisis
  on the distribution companies while it lasted, which the tribunal elected to do by

---

[138] *Id.* ¶ 432.

[139] *Id.* ¶ 433.

[140] *Id.* ¶ 433.

[141] *Id.* ¶ 434.

[142] *Id.* ¶ 435.

adjusting the tariffs – and thus the cash flows – that would have been permitted in the claimant's "but-for" scenario.[143]

Recognizing the potential impact of other factors on the projected revenues, the tribunal proceeded to adjust the asset base used to compute tariffs,[144] the projected tariffs themselves,[145] assumptions as to rates of consumption had there been no wrong,[146] and the impact of subsequent events on the actual value of the investments.[147]

Acknowledging that certain of its conclusions were "not the result of a sophisticated equation but a reasonable estimate,"[148] the tribunal laid out its conclusions and their underlying considerations in detail, including the resulting quantification of the components of the damage equation. While certain of the tribunal's conclusions may be subject to dispute, the detailed discussion of the subject by component made the scope of the tribunal's judgments apparent, narrowed the impact of any individual estimate and created a transparent record of the tribunal's decision-making process for the benefit of the parties before it as well as subsequent parties, advocates and tribunals.

IV.   CONCLUSION

Accounting for risk in determining the present value of cash flows projected for the life of an upstream oil or gas investment inevitably entails subjective judgment. Predicting the future, particularly in the remote areas in which such investments increasingly tend to be available to private international oil companies, cannot be reduced to formula, and the use of formulas can impart a misleading sense of precision that is

---

[143] *Id.* ¶ 436.

[144] *Id.* ¶¶ 418-28.

[145] *Id.* ¶¶ 438-45.

[146] *Id.* ¶¶ 446-50.

[147] *Id.* ¶¶ 451-59.

[148] *Id.* ¶¶ 444.

unjustified in light of irreducible uncertainty. However, by taking advantage of the market as a processor of information, breaking the task into manageable sub-issues and providing tools for the combination of the resulting parts, the methods developed through the disciplines of risk analysis and financial valuation widely used in the business world provide structured approaches directly linked to core financial theory. Moreover, proper application of these tools, advanced through expert testimony and tested by party advocacy, can be expected to yield results more closely attuned to real values in the market. Given the magnitude of the impact of uncertainty on value, failure to explicitly employ the best tools available for valuation risks introduction of significant error, for which there is no remedy. These methods do not and should not displace the arbitrator's consideration of all of the facts and circumstances, equitable and otherwise. But they provide a more rigorous framework to guide and discipline the evaluation of non-equitable factors, permitting transparent analysis even of the scope of equitable considerations.

The limited number of cases to have addressed this issue squarely to date have begun to illuminate the issues, without fully elaborating the principles that govern the choice of damage methodology. While arbitral decisions are not precedent, these decisions are nonetheless of crucial importance, as they are inevitably looked to for guidance by parties, advocates and tribunals. Moreover, obscuring proper financial analysis in discussions of the application of equity renders outcomes less predictable and feeds the sometime perception that arbitration is a process of "splitting the baby." Indeed, decisions that shun more rigorous analysis themselves function as guides, however imperfect, for future disputes, ostensibly endorsing more subjective decision-

making and leaving it to parties, advocates and arbitrators to replow the methodological ground each time, with the risk, each time, that variation from tested methods can lead to significant error. For advocates and arbitrators, the issue is at best arcane and fraught with difficult issues. Nevertheless its importance compels closer, more comprehensive discussion, debate and resolution.