Summary and Conclusions

Summary

The purpose of the WSPA Market Sales Study is to accumulate information regarding the marketplace for oil and gas properties in California and to make that information available to appraisers of such properties. While a wide range of data is collected and studied, the primary interest of the WSPA Study is the market value discount rate.

In the course of an in-depth review of the WSPA Market Sales Study done in 1999, it became apparent that, (1) while a substantial amount of data had been accumulated regarding oil and gas property sales in California and (2) significant efforts had been made in many of the annual WSPA reports to analyze that data qualitatively and quantitatively, the ability of an appraiser of an oil property to apply that information was limited. The primary limitations were that the appraiser who only had access to one or two WSPA Study reports would only be able to use the analysis and data presented in those reports, and, further, there was no mechanism whereby the data and analysis in one report could be integrated with the same data in another report. Some annual study reports contain extensive statistical analysis that include all sales data up to that point; other reports contain little new analysis. Finally, the issues and relationships addressed in each report changed from year to year, with certain analyses being done every year and others being done only once or twice over 15 years.

This report is comprised of (a) a compilation of the statistical and other analyses done for and presented in the WSPA reports starting in 1985 and continuing through 2001, and (b) new work done for this study using the sales data accumulated through 2001. The previous WSPA studies and the current study make use of both single and multiple regression analysis of discount rates to determine the relationship of the market value discount rate to physical, operational and economic parameters specific to the property(s) acquired. In the course of this study, 22 individual parameters were investigated. The results of the analyses are presented for each parameter as part of the text.

As noted by Peters and Summers, "*The major task of statistics is to provide a method for the use of objective evidence in the formation or modification of belief*." [1] This means that an appraiser should have a factual basis for decision making rather than relying on intuition, bias or on subjective measures such as "*quality*." With that purpose in mind, the WSPA studies have three objectives relative to the discount rate.

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[1] "*Statistical Analysis for Business Decisions*," Peters, William S. and Summers, George W., Prentice-Hall, Inc. 1968, pg. 7

Objective One: To identify and define the relationship that may exist between the market value discount rate derived from a sales evaluation and any of the economic, physical and/or transactional characteristics of the property and/or the evaluation from which the discount rate is derived. This objective requires that (a) the discount rates be derived from market value income streams in a consistent and accurate manner, (b) that all those components of the transaction and evaluation that could be considered to influence the discount rate be identified, and (c) the degree and nature of the relationship between the discount rate and every identified parameter or component be measured and described. Objective One is addressed through the use of several standard forms of statistical analyses, primarily Single and Multiple regression, to determine the relative strength of any relationship between the Discount Rate and the selected parameters. Single regression, as the name implies, tests each parameter individually in an attempt to determine the degree to which a change in the value of a parameter, such as Date of Sale or Purchase Price, causes a change in the Discount Rate. Multiple Regression tests the effect of changes in a combination of two or more parameters, such as Data of Sale and Purchase Price, on the Discount Rate. A total of 22 different parameters were tested individually and in combination. The parameters are divided into four groups. These are General Economic, Transaction, Property and Evaluation Parameters. The results of the Single and Multiple Regression analyses are discussed below.

Objective Two: To determine the basis upon which (a) individual discount rates derived from transaction evaluations can be compared one to another and within groups of sales, and (b) the common foundation for comparing groups of discount rates. The ability to derive discount rates from a number of sales and to then have a common basis of comparison between and among those sales and discount rates has general application in appraisal but is particularly useful in complying with SBE Rule 8(g)(1), [2] which requires that discount rates be taken from sales of "*comparable*" properties. This, in turn, requires that a basis of comparability of both properties and discount rates be determined.

Objective Three: To establish a framework which an appraiser of oil and gas properties may use to select a discount rate for use in estimating the market value of a specific property. The goal is to establish (a) a range of discount rates that are appropriate to the estimation of market value of typical oil and gas properties, and (b) a mechanism for the selection, from within that range, of a discount rate that can be applied to the estimation of market value for a specific property.

[2] California Administrative Code, Title 18, § 8 reported as California State Board of Equalization, Rule 8

In this study, three sets of data are used. A *Working Database* [3] comprised of 231 sales with discount rates between 0% and 42%; a sub-set of the Working Database consisting of 136 sales and known as the *Risk-Inclusive Database*; and a second but separate sub-set of 156 sales consisting of only those evaluations with *100% PDP Reserves*. All three data sets are normally, or near-normally, distributed about a Mean. Summary statistics are as follows:

Table I - Basis Analysis

See Appendix A for Definition of Terms

	WORKING DATABASE	RISK-INCLUSIVE DATABASE	100%PDP DATABASE
Number of Sales	231	146	156
Mean	24.0	24.0	23.2
Median	22.6	22.6	21.6
Mode	21.6	21.6	21.6
Standard Deviation	7.0	6.1	6.1
Skewness	0.64580	0.99760	0.81650

Single Regression Results

Single Regression analysis of the Working Database found that there is no statistically valid relationship between discount rate and any of the parameters that were tested with the exception of the Weighted Average Cost-of-Capital. Using annual averages, the market derived discount rate always exceeds the oil industry weighted average cost-of-capital.

A total of 22 different parameters were tested using Single Regression analysis. Regression formats included linear, exponential, logarithmic and polynomial expansions from Order 2 to Order 6. In many instances, the correlation of discount rate to the tested parameter improved with higher order polynomial equations, but the improved correlation required a tortuous curve fit that would be irrational for use in appraisal. The results of Single Regression using a Linear equation are tabulated in Table II for all three databases.

Single Regression analysis of the Risk-Inclusive Database found that the only factor that could be found to be statistically significant in comparison to other factors was the Reserves Risk, which is defined as the percentage of Proved Developed Producing (%PDP) reserves in the evaluation.

[3] The Working Database is obtained from the 2001 WSPA Report database of sales through year-end 2000.

Using Single Regression analysis of the 100%PDP Reserves data set, which removes Reserves Risk as a variable, no individual parameter was found to have a statistically significant relation to discount rate.

The results of the Single Regression testing of the various selected parameters for each data set is summarized in Table II and as follows:

General Economic Parameters

The study demonstrates that the discount rate is not a function of the Date of Sale. This singular finding is important in that it allows the use of all transactions from 1983 forward to be used for parameter analysis. The salient point of the entire analysis, and a factor that bears on all the other parameters tested, is the consistent relation of the market derived discount rate to the Weighted Average Cost-of-Capital or WACC. While no direct correlation is established, the demonstration that the annual average market-derived rate always exceeds the annual average BFIT WACC is exceptionally informative. This is the relation that is suggested by accepted financial practice and strongly reinforces the utility of the market-derived rates as being representative of the rates that would be expected by knowledgeable and informed buyers and sellers of oil and gas properties. The results obtained from this analysis indicate (i) that the BFIT WACC is a minimum rate, and (ii) that the discount rate used for a specific property should be several percentage points higher than the WACC, with the final rate being a function of the other parameters in the evaluation.

Transaction Parameters

Transaction Parameters, such as Purchase Price and Reserves Volume, have often been cited as factors which are related to or influence the discount rate. The analysis done for this study clearly shows that there is no significant relationship between the Discount Rate and Purchase Price, Total Required Investment, or Reserves Volume. The Purchase Price is a function of the application of the Discount Rate to the anticipated Income Stream, and, therefore, the Discount Rate must be known before the Purchase Price can be determined. The same consideration applies to Total Required Investment where the largest component is the Purchase Price.

The relationship of the discount rate to the Volume of Reserves is statistically insignificant. The argument is often made that larger properties, as measured by reserves, should be valued using lower discount rates because of a perceived lower risk due to the larger volume. The net result would be that Buyers would be expected to pay a premium for large volume properties. The study found no support for relating the discount rate to the Volume of Reserves.

The Location of a property has been shown to be unrelated to the discount rate since all the characteristics of a property that might be related to the Location, such as oil gravity and production/operating conditions, are commonly incorporated into the Income Stream and are not incorporated into the discount rate.

The only parameter that can be shown to have a relation to the discount rate is Reserves Risk. This parameter is measured by the percentage of Proved Developed Producing (%PDP) reserves that are included in the Buyer's evaluation. The analysis results strongly suggest that the discount rate increases as a function of the perceived risk in the property, where the "*risk*" is considered to increase as the proportion of PDP reserves is diminished. The Reserves Risk relation is by far the strongest relation found in the entire Study. However, Reserves Risk only accounts for about 30% of change in discount rate.

Property Parameters

Property parameters include the Initial Oil Price, Oil Gravity, Number of Wells, Production Method, Initial Production Rate, Reserve to Production Ratio and Production Rate Ratio. These are elements of the evaluation specific to the property being valued. The analysis found that, with the exception of the Reserve to Production Ratio, none of the tested parameters demonstrated a relationship to the discount rate that would allow the parameter to be used to aid in selecting a discount rate for market valuation purposes. Each of the parameters are taken into account as part of the income stream in the production projection, the product price and/or operating costs. These factors do not represent unknowns or risks that might be need to be included in the discount rate. The Production Rate Ratio demonstrates a marginal relationship to discount rate that could be considered to be a response to risk, but the same risk is also measured more directly by the Reserves Risk.

The Reserve to Production (R/P) Ratio demonstrates some relationship to discount rate. The R/P Ratio has been used in industry as a measure of the longevity of a property in comparison to other properties. If longevity is considered to be a risk related parameter, then the Reserve to Production Ratio could be used along with other factors in defining an appropriate discount rate.

Evaluation Parameters

Evaluation components are those factors that are imposed on the property appraisal by the evaluator or that result from the imposition of those criteria. The tested parameters include the Rate of Change of Product Prices, Reserve or Economic Life, Future Capital Investment, and Operating Costs.

The relation of the discount rate to changes in Product Prices is a relatively controversial subject that has been tested several times in previous WSPA studies. Those studies and the current work show that discount rate is not a function of whether or not product

prices increase, decline or remain the same over the course of an evaluation. Further, there is no apparent reason that they should be related except in a Real/Nominal sense. Rather than increasing or decreasing the discount rate to account for future projected changes in oil price, the appraiser should focus on the return required for the property risk perceived and modify the purchase price he is willing to pay for the property.

Reserve or Economic Life is, by definition, a function and result of the duration of the Income Stream and has no relation to the discount rate.

Future Capital Investment, as tested by the Capital Ratio and the Present Worth Capital Ratio, demonstrates no valid relation to the discount rate. The presence of future capital investment in an evaluation could be considered as an indirect measure of risk if the investment was for the development of new reserves or the introduction or expansion of enhanced recovery, but there are numerous other purposes for capital expenditures that do not add risk to the evaluation.

Operating Costs are tested by the Income Ratio, which measures income before operating costs relative to income remaining after operating costs. The Operating Costs are fully considered as part of the Income Stream. The analysis demonstrates that there is no relationship between the Income Ratio and the discount rate.

Multiple Regression Analysis

Multiple Regression Analysis was done to determine if a combination of more than one parameter could produce an improvement in the relationships to discount rate found by Single Regression. It is apparent from the tests conducted as part of the Current study that the Reserves Risk measured as % PDP Reserves is the dominant parameter in relation to discount rate. The addition of other factors to % PDP changes the Correlation Coefficient (R^2) only marginally. Removal of %PDP Reserves from the combination of parameters causes a substantial decline in R^2 and in the strength of the relation. The best marginal increase in R^2 is obtained through the combination of %PDP Reserves, Production Rate Ratio, Initial Production Rate, and Number of Wells.

Conclusions

The WSPA Study is a Representative Sample

The 231 sales contained in the current 2001 WSPA database and used in this study are a representative sample of (a) all properties that have transferred at market value in California between January 1983 and December 2001, and (b) all properties in California that could have been transferred at market value between 1983 and 2000 inclusive.

Objective One - Relationship of Discount Rates to Parameters

With the exception of (1) Cost-of-Capital and (2) Reserves Risk, along with one or more parameters related to Reserves Risk, there is no parameter normally used in an Income Approach appraisal that is related to the Discount Rate or which can be used to explain a difference in discount rate among market value transactions. Reserves Risk is defined as the percentage of Proved Developed Producing (PDP) reserves (%PDP) in the total reserves of the property being valued. As shown in Table II, R^2 rarely exceeds 0.10 for any of the parameters tested. These results verify the Three Component Model of the Income Approach where Value is estimated by applying the Discount Rate to the Income Stream.

Virtually all of the parameters tested in this Study are fully accounted for as components of the Income Stream. They are not a part of, or a function of, the Discount rate. The Cost-of-Capital and Reserves Risk are the exceptions that help to prove the rule. The Cost-of-Capital is a part of the Discount Rate and forms the minimum or base rate to which Risk, in the form of Reserves Risk or any other definable risk, is additive.

Objective Two - Comparability of Source Transactions and Derived Discount Rates

The results of this study and previous WSPA studies clearly indicate that out of a sample of 256 transactions spanning the period from 1983 through 2000, there is no single element or combination of elements in the General Economy, the Transaction, the Property itself, or the Evaluation parameters that act to make any sale not comparable to another for purposes of discount rate derviation. None of the usual concerns seen in Comparative Sales analysis, such as Date of Sale, Location, Property Size or other factor, can be shown to influence the discount rate as they might influence purchase price. It was found that only two factors have any apparent influence on the discount rate: the Cost-of-Capital and Reserves Risk. The discount rate always exceeds the Cost-of-Capital and increases from a base rate for PDP reserves to higher discount rates for Proved Behind Pipe (PBP) and Proved Undeveloped (PUD) reserves. Therefore, the COC must typically be adjusted upward to reflect property risk factors.

Comparability of the source of data is always an issue in property appraisal regardless of which appraisal method is used. In the Comparable Sales approach, the source transactions must be comparable because the primary point of comparison between properties is the purchase price. Adjustments are made to account for differences among the comparable

Table II
Single Linear Regression
Using 2001 WSPA Database

	Working Database		Risk-Inclusive Database		Risk-Inclusive Database Range of 1SE	
	R	**R^2**	**R**	**R^2**	**R**	**R^2**
Discount Rate vs.						
Date-of-Transfer	-0.06212	0.00386	0.08408	0.00707	-0.03827	0.00146
Reserve Volume	-0.08432	0.00711	-0.01878	0.00035	0.19485	0.03796
Purchase Price	-0.07306	0.00534	-0.07576	0.00574	0.19903	0.03961
Total Req. Investment	0.15341	0.02353	-0.07697	0.00592	-0.17049	0.02907
%PDP Reserves	-0.13357	0.01784	-0.51173	0.26187	0.43819	0.19201
ESCIndex 5	0.04583	0.00210	0.05700	0.00385	0.04319	0.00187
ESCIndex 10	0.03051	0.00093	0.15068	0.02271	0.19817	0.03927
R/P Ratio	0.02843	0.00081	0.15184	0.02305	0.06127	0.00375
Income Ratio	-0.07343	0.00539	-0.07608	0.00579	0.07400	0.00548
Production Rate Ratio	0.05882	0.00346	0.33518	0.11235	0.10541	0.01111
Initial Production Rate	-0.07777	-0.00605	-0.08737	0.00763	-0.10442	0.01090
Oil Gravity	0.01702	0.00029	-0.02310	0.00053	-0.05109	0.00261
No. of Producing Wells	-0.17358	0.03013	-0.10482	0.01099	-0.10716	0.01148
Economic/Reserve Life	-0.08001	0.00640	-0.00864	0.00007	0.09426	0.00889
Capital Ratio	0.06625	0.00439	0.44135	0.19479	0.32521	0.10576
P.W. Capital Ratio	0.08814	0.00777	0.35198	0.12389	0.22026	0.04851

properties. This approach requires two sets of data. First, a collection of sales and purchase prices that can be deemed to be comparable. Second, a set of criteria based on the attributes of the transactions and properties that (a) allows the appraiser to determine whether the sales are comparable, and (b) contains sufficient data regarding the properties and sales from which the appraiser can extract information on which to adjust to the purchase price.

In the Income Approach to value, it is the discount rate that is derived from comparable sales, rather than the purchase price. The sales that are used as a source for discount rates must be "comparable," but the basis for comparability is measured by reference to features affecting the discount rate. The market value discount rate has been shown to be unrelated to (1) changes in general economic conditions, (2) the terms of a specific transaction, (3) the attributes and characteristics of the property, and/or (4) the parameters included in the evaluation. Therefore, discount rates derived from market value transactions, evaluated using an Income approach based on generally accepted engineering and evaluation methods, should be considered comparable for purposes of deriving discount rates.

The statistical analysis conducted as part of the current study, and of prior WSPA Studies, provides substantial information with regard to the comparability of the sales transactions and evaluations from which discount rates are derived.

Objective Three - Selecting Discount Rates from Market Sales Data

The WSPA studies and the statistical analyses done for this study provide a rational foundation for the selection of market value discount rates for use in appraising oil and gas properties. In a broad sense, the selection requires a three-step process:

a. Determination of an Appropriate (Weighted Average) Cost-of-Capital

   Analysis of derived discount rates relative to annual average WACC for a large sample of oil and gas companies suggests (a) that the historical WACC is in the range of 14-18% Before Income Tax, and (b) that the property specific discount rate exceeds the WACC by 3-5 percentage points. The average WACC over the 1985-2000 period is about 15% BFIT. More than 90% of market derived discount rates exceed 15% BFIT.

b. Determination of Property Specific Risk

   Market derived discount rates span a wide range of values but are normally or near-normally distributed about a Mean/Median and demonstrate a strong central tendency with a range from 19-20% for 100%PDP properties to 28-30% for properties considered to be 100% PUD (0%PDP). This range includes more than 70% of the sales evaluations in the Working Database. Selection of an appropriate discount rate for market value estimation would require a comprehensive Income Approach evaluation and a knowledge of the volumes of each class of reserves and an indication of other risk related factors such as Reserve/Production R/P ratio.

c. Refinement of Property Discount Rate

The percentage of Proved Developed Producing reserves can be used to select a rate from within the 19-30% range, with the other risk related factors used to further define the selected rate. While no other parameter demonstrates a relationship to discount rate that rivals or comes close to the Reserves Risk (%PDP), certain factors such as Reserve/Production Ratio and Reserve/Economic Life could be used to refine a discount rate decision within the ranges suggested by Reserves Risk.