Modeling Deepwater Exploration and Development Prospectivity in the U.S. Gulf of Mexico Region

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Presentation Outline

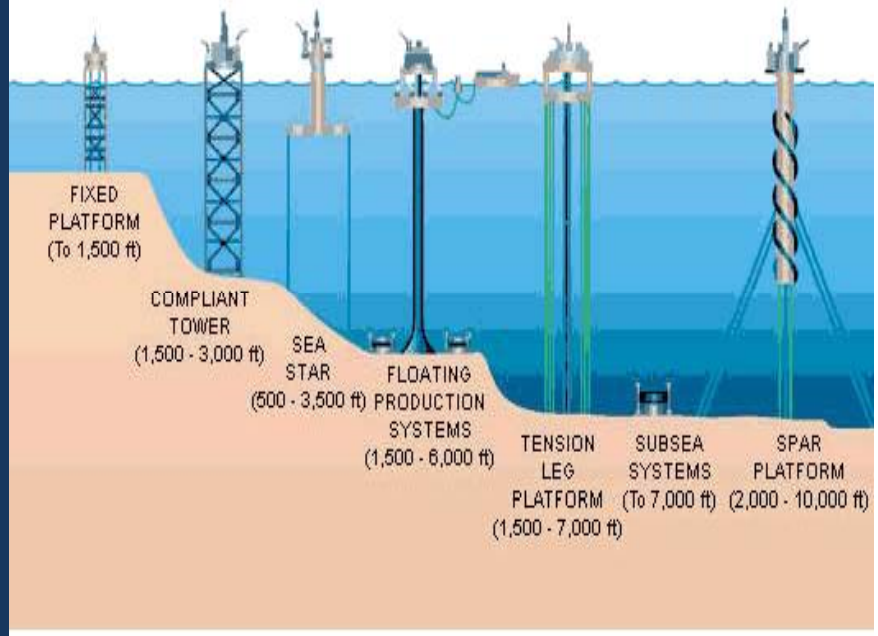
- Background
- Data Overview & Analysis
- Modeling Framework
  - Specifications
  - Model Results
  - Economic Interpretations
- Conclusions

Study Overview

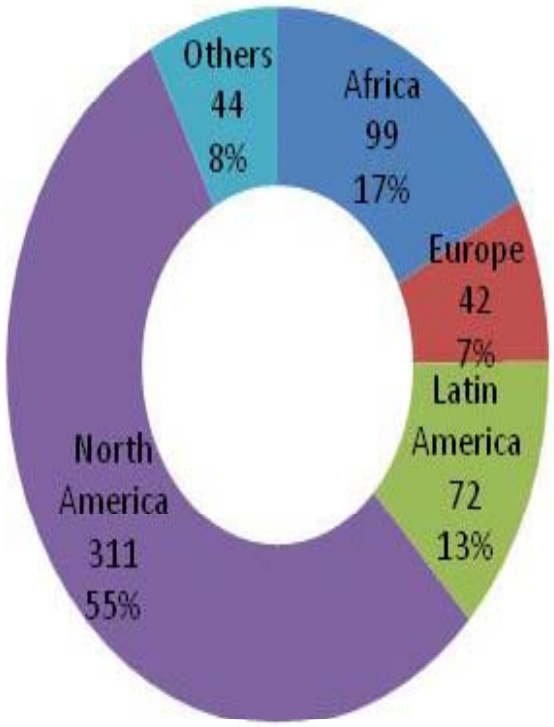
- Industry analysts once thought that the GOM Region could no longer attract big investors
- Today the GOM has re-emerged as the key focal point of oil and gas activity
- Why the turn around?
  - Technical advancements
  - Changing structure of the OCS oil and gas industry
  - Government regulatory programs and fiscal incentives
  - Global market fundamentals

Factors Affecting Deepwater Operations

Role of Technology (IEA, 2008, pp215)



Resource Accessibility



Factors Affecting Deepwater Operations

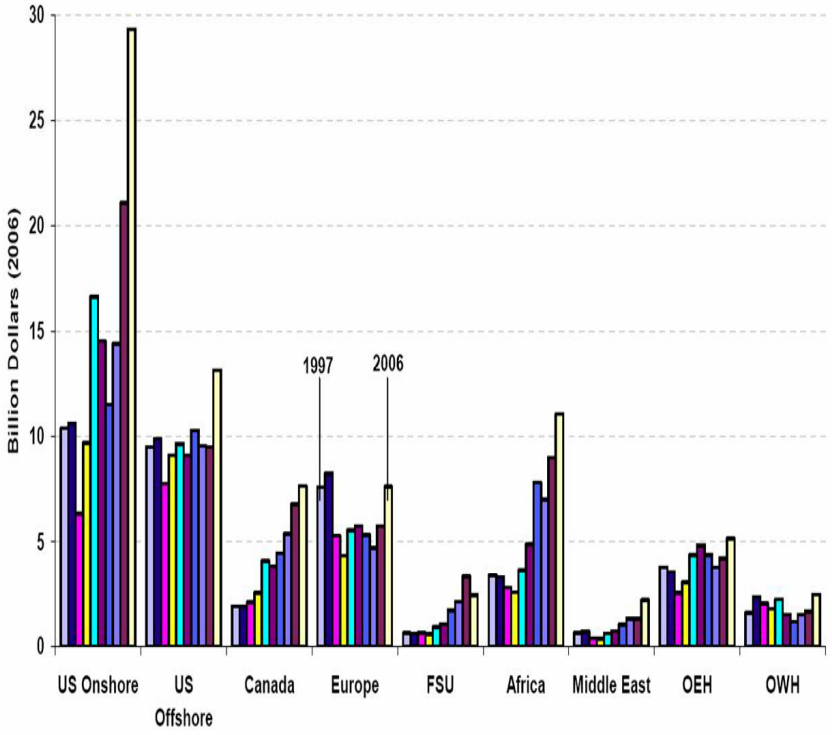
Role of Price

- Price is a signal that induces oil producers to find and produce oil and consumers to buy it.
- It establishes output and methods of production.
- Oil price is determined by the fundamentals of supply and demand
- Factors affecting supply & demand:
  - intensity of oil use,
  - extent of oil exploration,
  - growth in productive capacity,
  - and technology innovation.

Global Reserves and Price

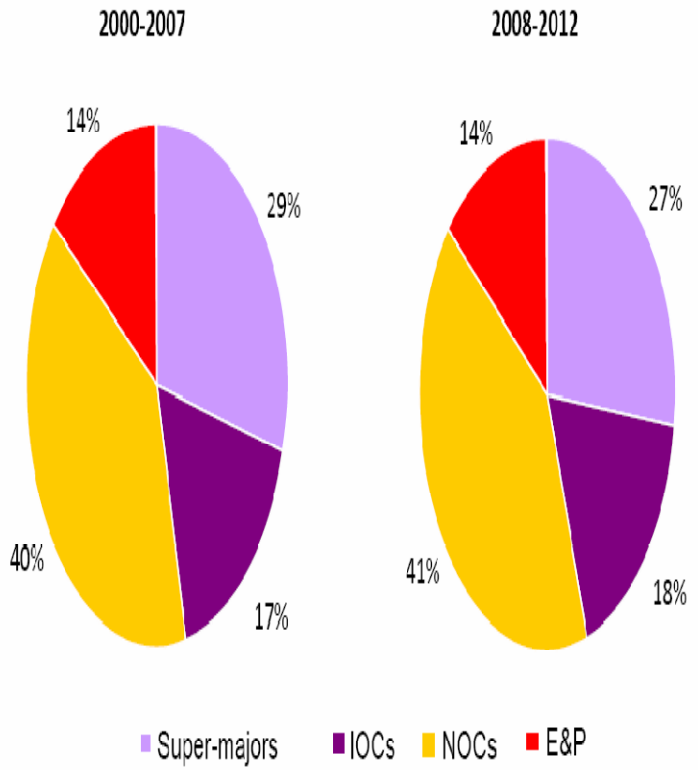
Factors Affecting Deepwater Operations

Capital Investment Flow

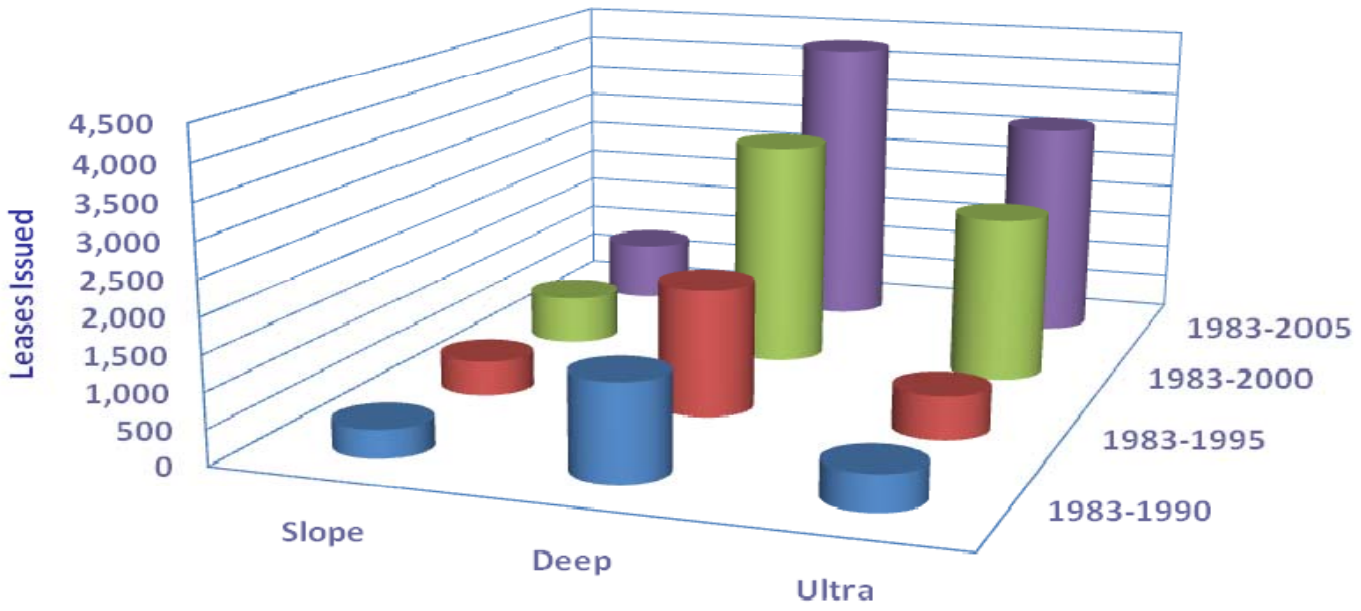


Note: FSU is Former Soviet Union. OEH is Other Eastern Hemisphere, which is primarily the Asia Pacific region. OWH is Other Western Hemisphere, which is primarily Central and South America and the Caribbean.
Source: Energy Information Administration, Form EIA-28 (Financial Reporting System).

Investment Distributions (IEA, 2008)

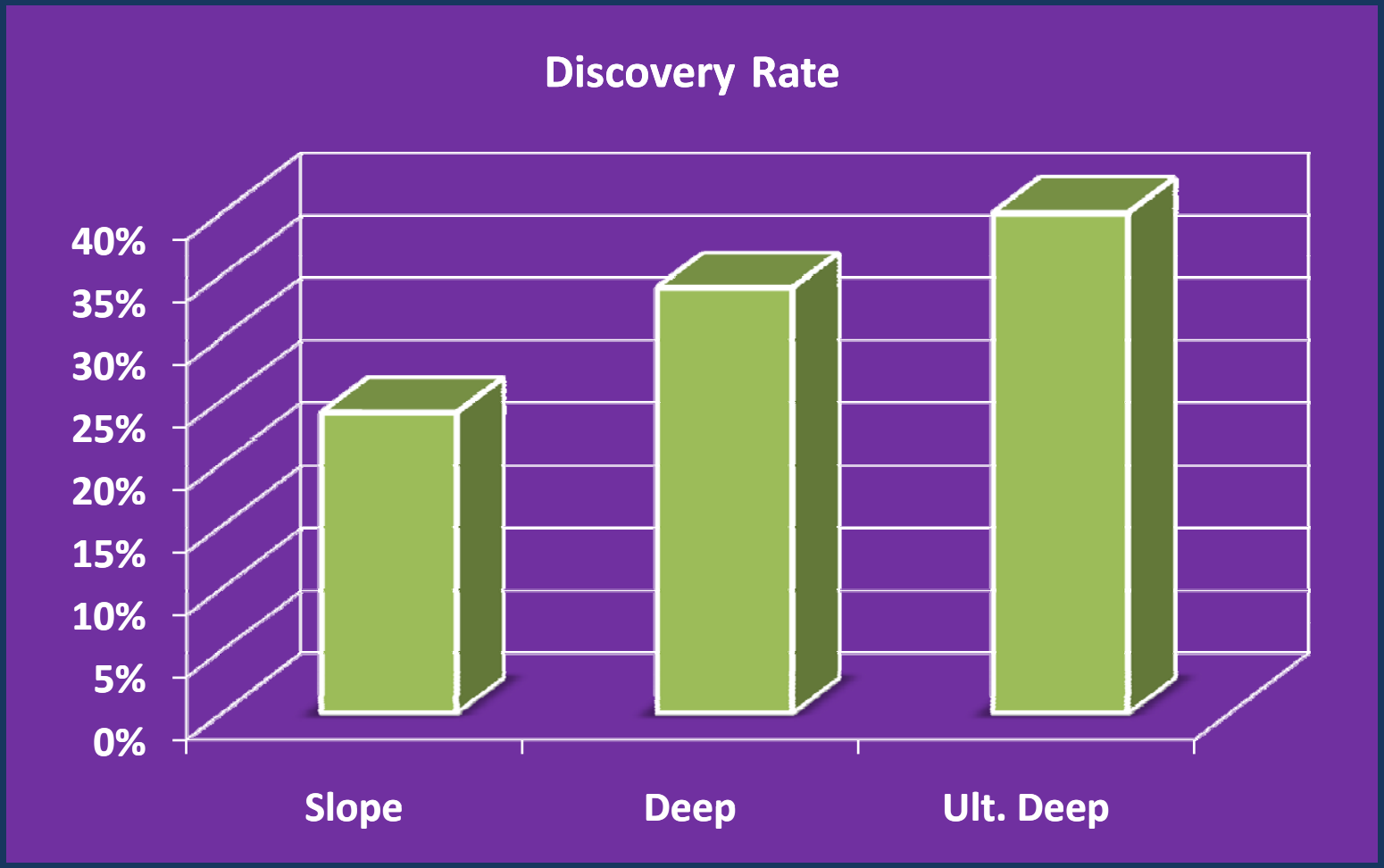


Deepwater Efforts: Cumulative Leases Issued

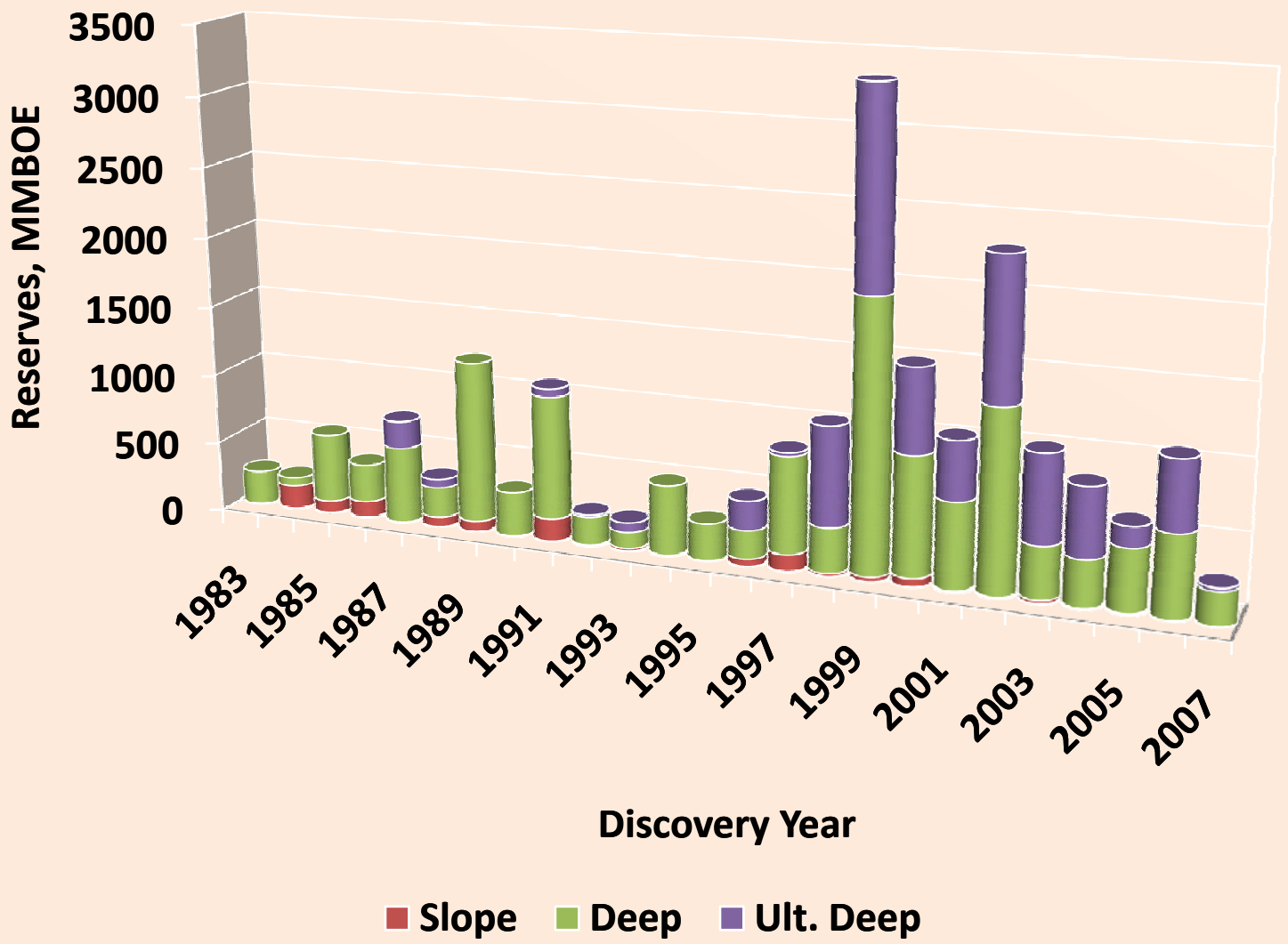


	Slope	Deep	Ultra
1983-1990	402	1,361	506
1983-1995	498	1,815	618
1983-2000	698	3,238	2,388
1983-2005	864	4,278	3,173

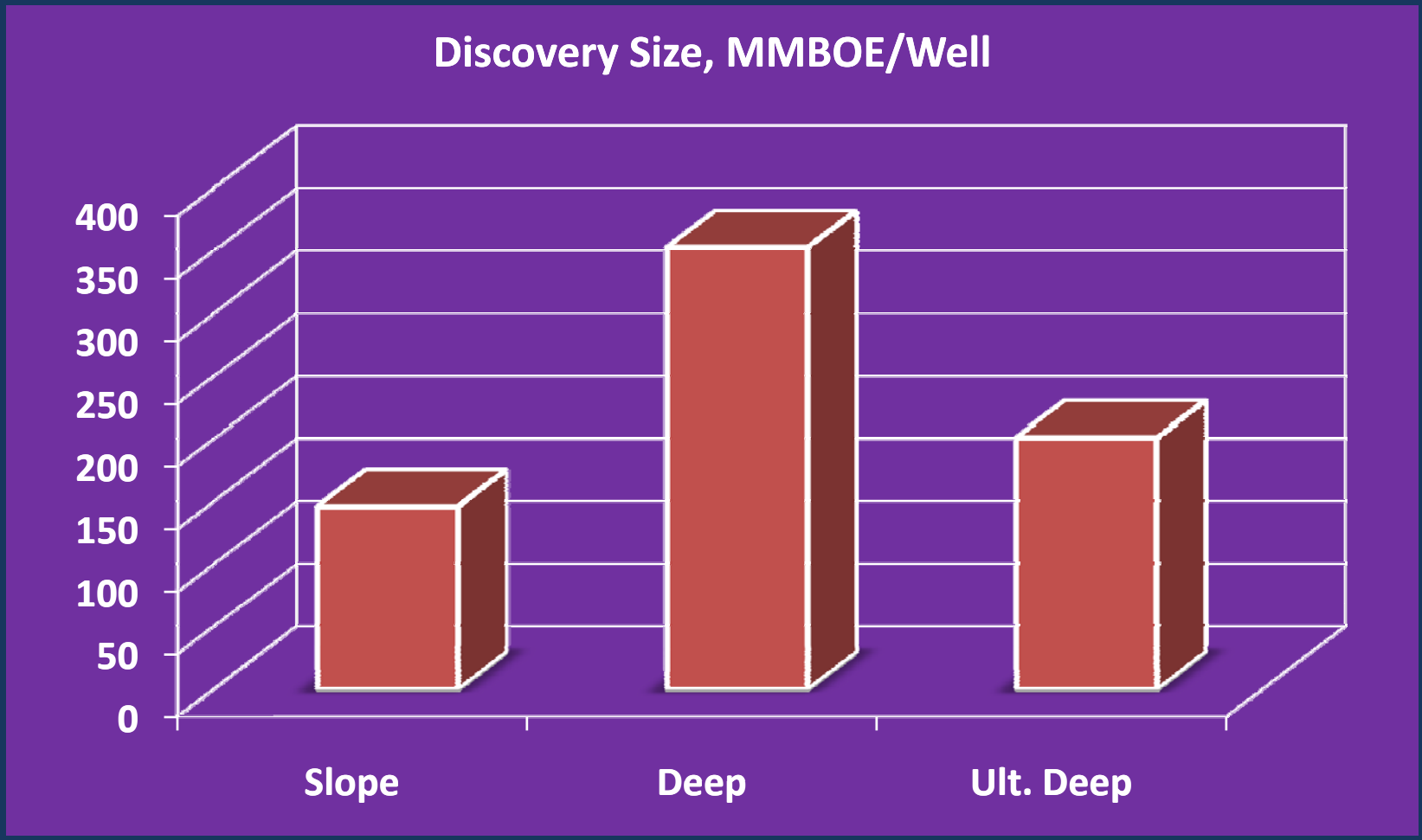
Data on Deepwater Drilling Outcomes



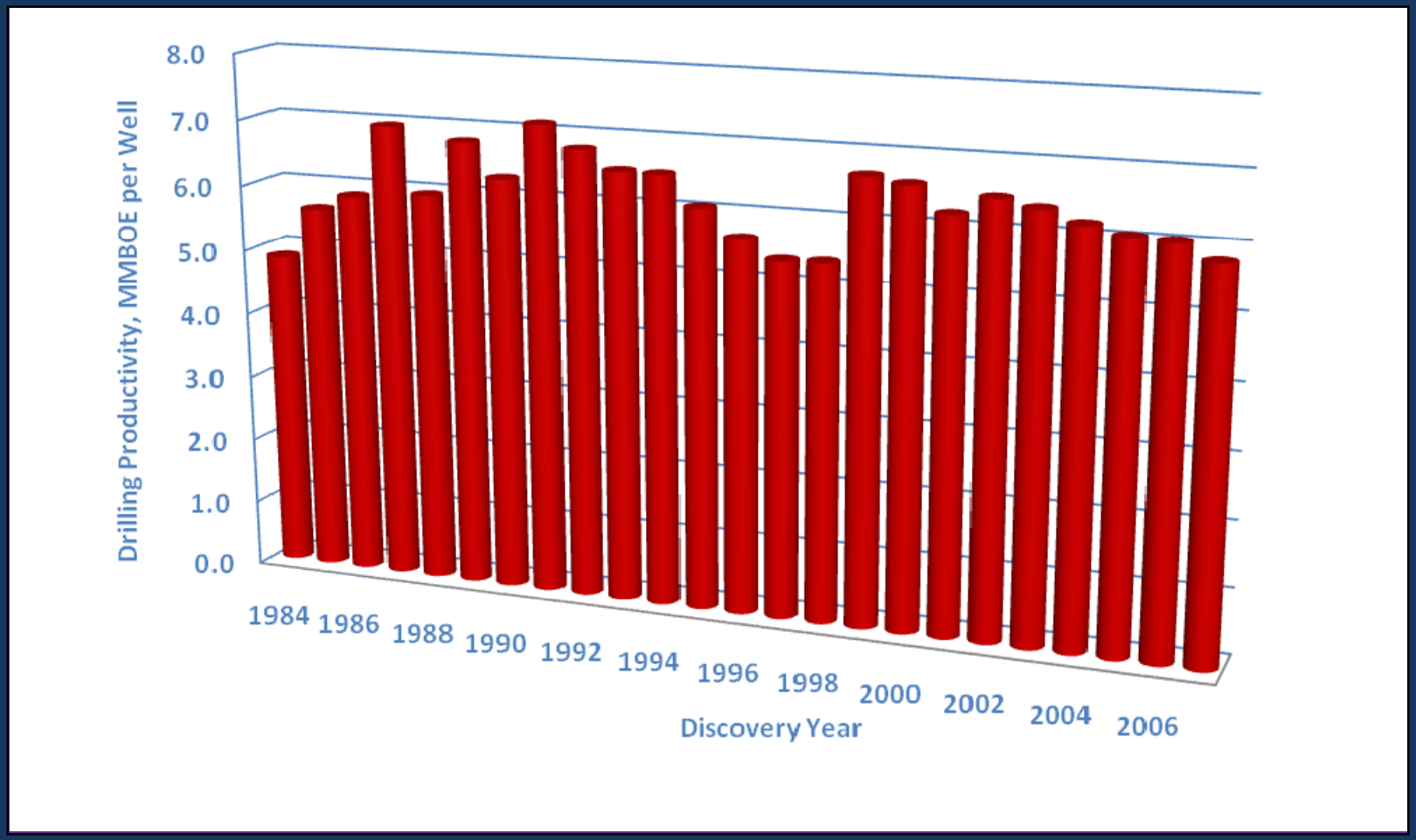
Deepwater Drilling Output



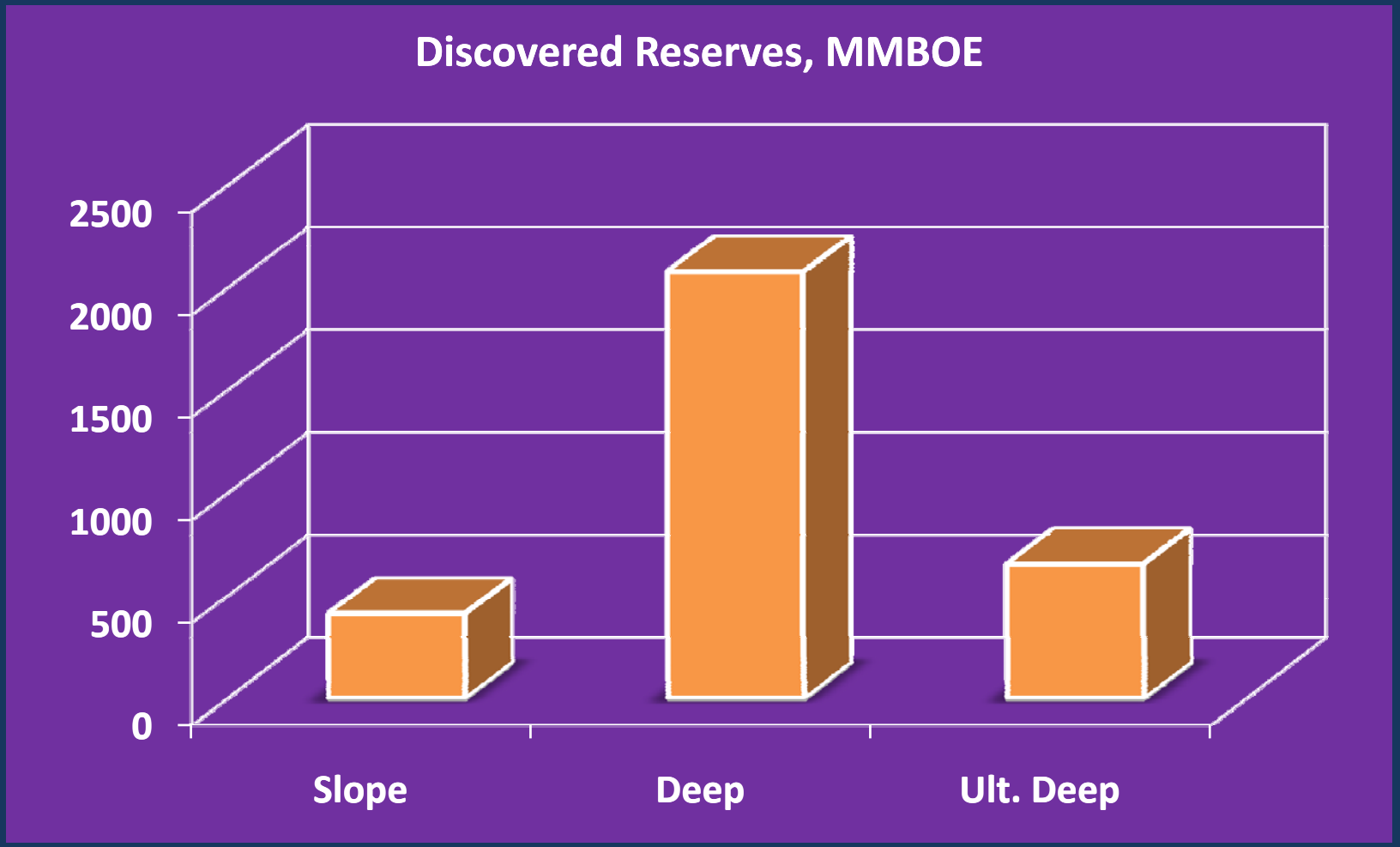
Data on Deepwater Drilling Outcome



Deepwater Drilling Productivity



Data on Deepwater Drilling Outcome



Modeling Deepwater Discovery Process

- Model assumptions
  - Resource availability
  - Economic and policy incentives
  - Technology
  - Stochastic nature of drilling outcomes
  - Generalized petroleum discovery process assumption

Model Specifications

- A hybrid-modeling frame work
- Assumes profit maximization
- As output price changes, a competitive firm will alter its drilling effort to satisfy an optimality condition:
  - Marginal value of reserves added equals the cost of an additional effort
  - The returns on drilling and development investment are to be maximized

Identity Equation

- $\Delta R = y(t) * x(t) * z(t)$
  - $\Delta R(t)$ = gross new reserves discovered in year t.
  - y(t) = average discovery size
  - x(t) = drilling rate
  - z(t) = average discovery rate.

Drilling Rate Equation

- $\ln w = \beta_0 + \beta_1 \ln W(t) + \beta_2 \ln P(t) + \beta_3 T + \varepsilon_1$
  - w = number of wells drilled to look for and develop hydrocarbon reservoirs over a given period
  - P = the expected value of new reserves
  - W = cumulative total well drilled at the beginning of time t
  - T = a proxy for technical progress
  - ε_1 = the random error term
  - β_i = constant parameters to be estimated for (i=0,1,2…)

Discovery Size Equation

- $\ln y = \alpha_0 + \alpha_1 W(t) + \alpha_2 \ln P(t) + \alpha_3 T + \varepsilon_2$
  - y = the finding rate of petroleum in thousand barrel equivalents per successful well.
  - P= current posted price of oil in dollars per barrel the random error term.
  - T = time trend, a proxy for technical change
  - α_i = constant parameters to be estimated (i = 0, 1, 2, and 3)
  - ε_1 = the random error term

Technical Discovery Rate Equation

- $\ln \Omega(t) = \lambda_0 + \lambda_1 W(t) + \lambda_2 P(t) + \lambda_3 T + \varepsilon_3$
  - $\Omega(t) = (z(t) / (1-z(t))$, the logistical transformation of the success rate z (t).
  - W (t) = cumulative number of wells, a proxy for resource depletion at the beginning of t
  - P= current posted price of oil in dollars per barrel the random error term.
  - T = a proxy for technical change
  - λ (i: i=0,1,2..) = constant parameters to be estimated.

Estimation Method

- To evaluate the impact of petroleum reserves discovery the identity equation was applied.
- Equations estimated using pooled lease squares
  - Cross-section seemingly unrelated regression
  - Corrected for cross-section heteroskedacticity
  - Corrected for contemporaneous correlation

Estimation Model Results

- The corresponding coefficients of the determinants of each component are applied to calculate the elasticity
- The data reported estimates relative to the mean values
- The estimates are calculated in accordance with the functional form
  - adopted to specify each component of the petroleum reserves addition model.

Drilling Rate Equation Results

Variable		Coefficient	Prob.	
Slope Dummy, D1		3.144	0.016	*
Deep Dummy, D2		7.726	0.000	*
Ultra Dummy, D3		12.352	0.000	*
DWRRA Dummy, DU		0.229	0.166	
Real Oil Price, log(PO)		-0.514	0.204	
Real Gas Price, log (PG)		0.715	0.066	***
Cumulative Wells, log(w)		0.367	0.002	*
Technology Index, (TK)		-10.947	0.000	*
R-squared	0.867		Mean Dependent Variable	8.675
Adjusted R-squared	0.840		S.D. Dependent Variable	2.931
S.E. of Regression	1.080		Sum Squared Residual	39.683
Durbin-Watson	1.731			

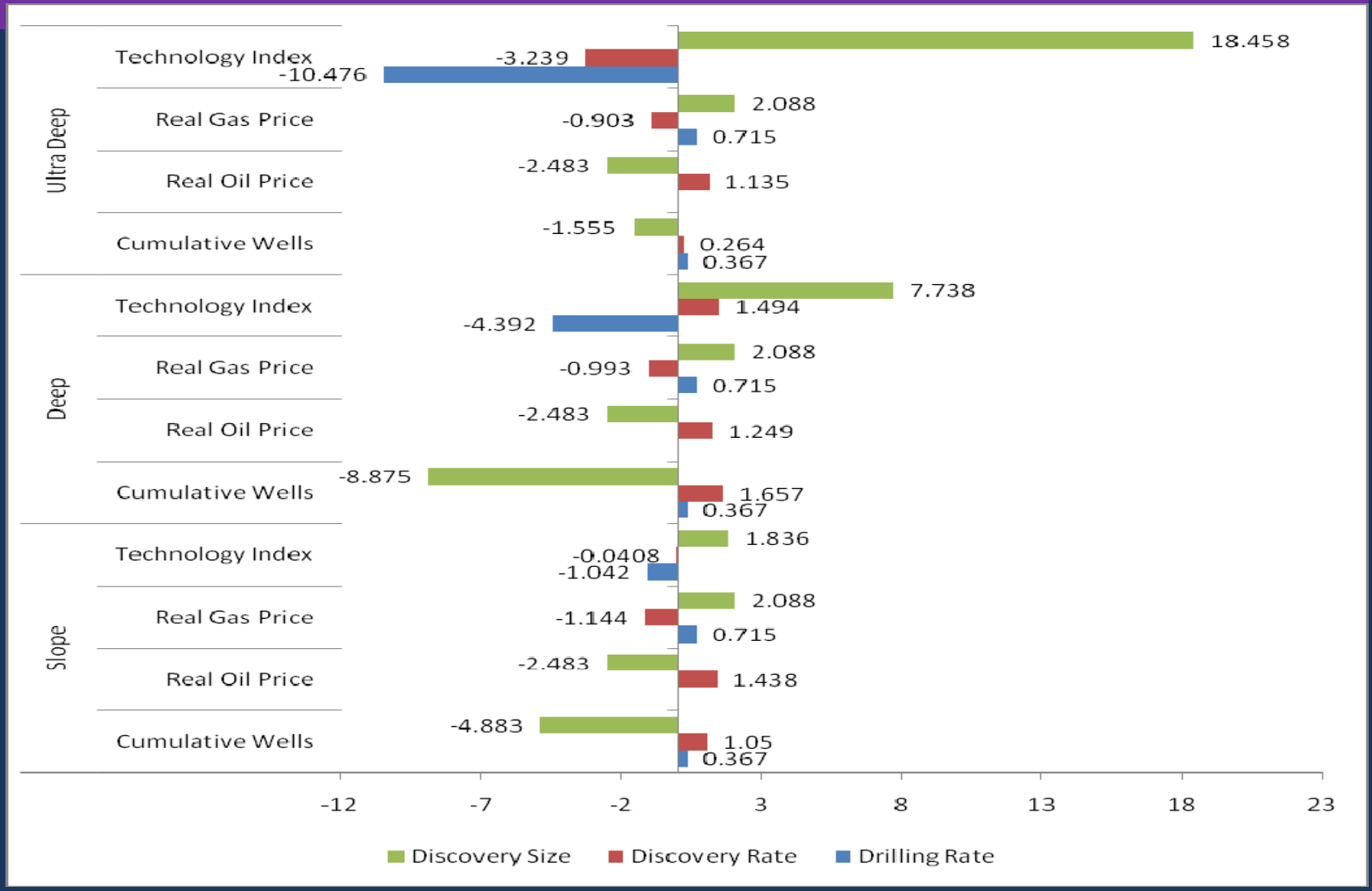
Discovery Size Equation Results

Variable		Coefficient	Prob.	
Slope Dummy, D1		17.577	0.000	*
Deep Dummy, D2		16.478	0.000	*
Ultra Dummy, D3		-0.651	0.901	
DWRRA Dummy, DU		1.496	0.023	*
Real Oil Price, PO		-0.088	0.096	***
Real Gas Price, PG		0.6959	0.077	***
Cumulative Wells, w		-0.011	0.000	*
Technology Index, TK		19.286	0.003	*
R-squared	0.797		Mean Dependent Variable	13.926
Adjusted R-squared	0.726		S.D. Dependent Variable	2.818
S.E. of Regression	1.127		Sum Squared Residual	25.417
Durbin-Watson	2.118			

Discovery Rate Equation Results

Variable		Coefficient	Prob.	
Slope Dummy, D1		-1.123	0.000	*
Deep Dummy, D2		-0.395	0.556	
Ultra Dummy, D3		4.329	0.017	*
DWRRA Dummy, DU		-0.3933	0.160	
Real Oil Price, PO		0.0671	0.012	*
Real Gas Price, PG		-0.5016	0.014	*
Cumulative Wells, w		0.003	0.000	*
Technology Index, TK		-5.64	0.005	*
R-squared	0.867		Mean Dependent Variable	8.675
Adjusted R-squared	0.840		S.D. Dependent Variable	2.931
S.E. of Regression	1.080		Sum Squared Residual	39.683
Durbin-Watson	1.731			

Economic Interpretations



Economic Interpretations

- One percent change in real gas price
  - Base line level drilling increased by .715 percent.
  - Lowered discovery rate by 1.144 percent
  - Improved discovery size by 2.088 percent
  - Discovered reserves may increased by 1.659 percent

Economic Interpretations

- One percent change in real oil price
  - No significant change in base line level drilling.
  - Improved discovery rate by 1.438 percent
  - Lower discovery size by 2.483 percent
  - Discovered reserves may fall by 1.045 percent

Concluding Remarks

- Deepwater production currently accounts for more than 70 percent of oil production
- Leases awarded from 1983-2005 represent 45 percent of total leases
- One out of 25 leases granted were declared productive
- For a dollar increase in natural gas prices, reserves can increase by
  - 228 MMBOE in the slope
  - 1,254 MMBOE in the deep
  - 414 MMBOE in the ultra deep

Concluding Remarks

- Similar increase in real oil prices reduces reserves by
  - 15 MMBOE in the slope
  - 91 MMBOE in the deep
  - 31 MMBOE in the ultra deep.
- Model results show the impact of resource depletion is mitigated with technical progress.
- The estimated net impact of technology growth and resource depletion is
  - 1,355 MMBOE for the slope
  - 7,858 MMBOE for the deep
  - 2,822 MMBOE for the ultra deep