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Capital Investment Decisionmaking and Trends: Implications on Petroleum Resource Development in the U.S. Gulf of Mexico

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ABSTRACT

Many factors impact the demand for and supply of oil and natural gas, influence how and where energy companies invest their capital, and determine the manner in which countries compete to attract foreign investment. World oil supply derives from the investment decisions of individual companies, the political decisions of countries in regard to licensing and degree of foreign investment, and a multitude of other variables that influence system dynamics, including pric

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1. EXECUTIVE SUMMARY

The demand for oil and gas begins at the individual and corporate level. Individuals drive cars, heat and cool their homes, and consume food and other services, all of which require – either directly or indirectly – oil, gas, and petroleum-derived products. Industry provides goods and services that require energy to function.

Many factors impact the demand for and supply of oil and natural gas, influence how and where energy companies invest their capital, and determine the manner in which countries compete to attract foreign investment. The relationship between the various factors and their relative importance is subj

2. INDUSTRY CHARACTERISTICS

2.1. Business Functions

Oil and gas companies may be involved in several different types of functions:

- Exploration, development, and production,
- Transportation,
- Refining,
- Marketing and distribution, and
- Petrochemicals.

The "upstream" segment of the business refers to exploration and production (E&P) activities; refining and marketing is "downstream," and transportation is the "midstream" segment of the business.

Companies which operate in all segments of the industry are fully integrated, while companies that operate in one or more but not all segments are called partially integrated or independents. An independent oil producer, for instance, is primarily involved in only E&P; an independent refiner is involved primarily in refining. The largest integrated oil companies are referred to as majors or supermajors. Various other categorizations are also frequently used, such as international integrated, U.S. integrated, large independents, small independents, etc. based on market capitalization, proved reserves, and related criteria.

2.2. U.S. Upstream

A large number of independent producers and a smaller number of fully integrated companies characterize the U.S. upstream. According to the Energy Information Administration (EIA), in 2001 there were 179 large[1] operators in the United States, which accounted for 84.2% crude oil production; 430 intermediate operators, which accounted for 5.8% production; and 22,519 small operators, which accounted for 10% production.

In the U.S. offshore industry, 319 working interest owners were reported[2] in the Gulf of Mexico at the end of 2003. The vast majority of companies in the Gulf of Mexico are small, independent firms, but just 21 companies hold the majority of production responsible for over 80% of 2003 production (Kaiser and Pulsipher, 2006). The top four producing companies (Shell, Chevron, BP, ExxonMobil) are responsible for over 40% total Gulf of Mexico hydrocarbon production.

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[1] The EIA defines large operators as producing a total of 1.5 million barrels or more of crude, 15 billion

2.3. U.S. Downstream

The structure of the refining industry has undergone significant change over the past decade. Once led by a half-dozen vertically integrated majors, the industry is now characterized by a handful of super-majors and an array of mid-size and small independents focused on refining and marketing within specific regions and product lines. Independent refiners and marketers are typically only involved in downstream activities. The traditional industry model of refining, based on ownership by vertically integrated oil companies and profitability viewed within the context of a linked supply chain, has been replaced by refineries operated in a stand-alone profit center mode.

Before 1980, nearly all U.S. refineries were held by integrated oil companies, while today, ownership structure is more diverse and concentrated. In 2005, the top three U.S. refiners processed 36% of total crude oil; the top 10 refiners processed 77%; and the top 20 refiners processed 92% (API, 2005). Independents currently own about 64% of U.S. refining capacity versus 51% in 1990. Foreign ownership has risen from 19% of total capacity in 1990 to about 25% in 2005. Royal Dutch Shell, BP, Total, Saudi Aramco, and Petroleos de Venezuela SA are major foreign owners of U.S. refining capacity.

The majority of distillation capacity is currently concentrated in large, integrated companies with multiple refining facilities. Fifty-five firms, ranging in size from 880 barrels per day (BPD) to a combined refinery capacity of 1.8 million BPD comprise the industry (EIA, 2005). About two thirds of firms are small operations producing less than 100,000 BPD and representing about 5% of the total output of petroleum products. Large refiners often manage both large and small refineries, while small operators mainly specialize in asphalt, lubricants, and other niche products. Integrated firms such as ConocoPhillips, ExxonMobil, BP, and Chevron maintain a global portfolio of petroleum assets. Independent companies like Valero and Sunoco focus primarily on domestic refining, although they may also be involved in marketing and other operations. Several joint ventures and partnerships also exist.

2.4. Business Characteristics

Oil and gas exploration and development is a high risk, capital intensive business. Finding oil and natural gas throughout most of the world is difficult, costly, and uncertain. The cost of obtaining leases and conducting exploratory work requires an enormous investment before reserves are quantified and economic viability ensured.

The expenditure of millions and sometimes billions of dollars is required for a single project, with no guarantees on the success of the outcome. Investment, in its most basic form, is paying now for the purpose of a reward later. Particularly in oil and gas ventures, however, there are risks of various kinds that need to be considered. Does oil exist in the region? If reserves are found are they smaller than expected or decline faster than geologic conditions suggest? The quality and quantity of the resource is uncertain because it exists deep underground in heterogeneous rock formations, and as a deposit is produced, the cash flows are subject to various forms of uncertainty and risk (Table A.1). Will drilling lead to a blow-out? What is the probability of an earthquake, mudslide, or hurricane destroying the facilities? Will oil prices remain strong or nose-dive? How will inflation rates behave? Will the government try to renegotiate the terms of the contract at a later date? Is nationalization a risk?

Risks arise from the project (construction, operation, production, reserve), as well as changes in global economic conditions (market, macroeconomic), political circumstances (regulatory, expropriation), legal conditions (contract, jurisdictional), and force majeure (natural disaster, civil unrest, terrorism). The higher the risk associated with an investment, the higher the cost of capital and the higher the return required by investors and lenders (Grayson, 1960).

After a well is drilled, the reservoir drive pushing the oil to the surface will progressively exhaust itself if no additional investment is made (Dyke, 1997). To produce at a high rate of extraction requires more wells, greater production and storage facilities, and greater transportation capacity. A complex trade-off exists between producing “fast” (large number of wells, high capital expenditures) or “slow” (fewer wells, low capital expenditures).

The long-lived nature and high capital cost and risk characteristic of E&P projects result in a long payout period, and due to the nature of the resource and project life cycle, there is generally a significant time delay between the magnitude of expenditure and the value of the reserves. This time delay results in significant problems in accounting for oil and gas operations, as well as measuring performance, because there is no direct correlation between the magnitude of expenditures and the value of reserves (Gallun et al., 2001).

The oil and gas industry is large with some of the world’s largest corporations. In the U.S., 29 major energy companies in 2004 reported operating revenues of $1.13 trillion, equal to about 15% of the $7.4 trillion in revenues of the Fortune 500 corporations (U.S. Energy Information Administration, 2005).

The structure of the oil and gas industry is dynamic and highly competitive. Majors, independents, and National Oil Companies (NOCs) each have different business models,

characteristics (GDP per capital, economic strength, corruption index, reserves), strategic priorities (revenue growth, security of supply, profit/margin, local economic development, international/diplomatic relations, infrastructure development), etc. Demand-side NOCs are changing the nature of competition, offering supply-side NOCs strategic partnerships that extend to economic and infrastructure development. The political alignment between nations and their oil companies can bring a distinct competitive advantage, which will further increase competition for multinational companies in acquiring investment opportunities.

In terms of reserves, over 90% of the proved oil reserves in the world are under direct or partial state ownership, primarily in the Middle Eastern OPEC countries. The top 10 oil and gas company rankings by reserves and production for oil (Table A.5) and oil and gas (Table A.6) illustrates the absolute strength of NOCs. PFC Energy estimates that 65% of the world's proven oil and gas reserves are controlled by governments not open to western companies; 16% proven reserves are held by Russian companies; 12% by governments with limited access for investment; and 7% with full access (Ball, 2006).

2.6. Mergers and Acquisitions

Mergers and acquisitions in the oil and gas industry occur for various reasons, generally related to the need for increased efficiency and cost savings (U.S. General Accounting Office, 2004), and increasingly, the need to compete with demand-side NOCs and offer synergies with international partners. Merger and acquisition activity may also be driven by the desire or need to diversify assets, enhance stock values, and respond to price volatility. From 1991-2000, over 2,600 merger transactions occurred in the oil industry (U.S. General Accounting Office, 2004). The vast majority of the mergers (approximately 85% of the total) occurred in the upstream segment, involving one company purchasing an asset from another company, such as a refinery, pipeline, or producing properties. The downstream segment accounted for about 13% of the mergers; the midstream segment about 2%. The majority of the reported transaction values were below $50 million, and over 89% of these mergers were asset transactions. About 32% of the mergers exceeded $50 million and 3% were over $1 billion.

2.7. Corporate Strategies

There are many strategies that a company may pursue in exploration, development, and production activities. The basic strategy that a company adopts, and the factors that drive the selection, provides information on the way companies do business and view the outlook of their industry. Strategies for public companies are frequently disclosed at investor and Board of Director meetings and can be inferred from annual reports, whereas strategies for NOCs may not be articulated or known outside the company. The diversity and depth of strategies that exist in the industry is significant, and no categorization is sufficiently descriptive to encompass all possible cases. Categories may change as internal (staffing, assets, successes, failure, etc.) and external (oil price, markets, interest rates, etc.) circumstances are played out.

For the purposes of discussion, we apply the following classification:

- No specialty,
- Geographic specialty,
- Technological specialty,
- Low cost specialty, and
- Risk specialty.

Companies may specialize within a single category or simultaneously pursue projects that fall within two or more categories. No specialty strategies are commonly carried out by the large integrated companies to help ensure that failure in one or more areas is compensated by success elsewhere. Oil and gas companies that hold geographically diverse assets across all parts of the supply chain are less vulnerable to specific events than companies that hold assets in one part of the supply chain in one geographic region. Breadth of operations allows companies to reduce the volatility of their return on investment and reduce their cost of capital. Integrated oil and gas companies tend to have lower volatility of their return on investment than independent companies.

2.8. Corporate Goals

The three primary objectives of every corporation are to:

- Increase its equity appreciation (total worth) to survive and grow,
- Control the total cash flow within, into, and out of the corporation, and
- Maintain or increase some form of dividends to shareholders.

To accomplish these tasks, the company must receive an average positive rate of return on its portfolio of investments. Since projects and investments appear as cash flows, the control of cash usually has some form of corporate decision rules and procedures (Lerche, 1992). The criteria to give a dividend, repurchase shares, or invest in projects are the capital budgeting decision.

2.9. Capital Budgeting Process

Budgeting is practiced by all public, private, and National Oil Companies, but because of its encompassing nature, a standardized definition does not exist. A budget is usually considered the principal management vehicle for the expression of a company's plans and objectives for a specified period of time (normally twelve months).

A capital budget is a fixed asset spending plan which in the oil industry tend to occur on a project-by-project basis. A profitable[3] oil company is the combination of profitable projects, and since each project has a different risk-reward strategy, oil companies try to build a diversified portfolio to maximize the return to their shareholders.

The typical capital budgeting process follows three steps:

1. Identify all non-discretionary (mandatory) capital expenditures; e.g., new government regulations, corporate policy, previously initiated projects.
2. Establish the level of funds available for discretionary expenditure.
3. Select investments in descending order of rank until either the total available funds are exhausted or the minimum acceptable yard stick value reached.

Each step will vary from one organization to another with various techniques and criteria employed in ranking investment opportunities. Large organizations tend to rank investments using different criteria and emphasis than smaller companies. The volume and quality of investment opportunities, and the immediate cash position of the organization, also impact the way the rankings are perceived and ranked.

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[3] The Royal Dutch Shell statement of general business principles is standard:

> *"Profitability … is essential for the proper allocation of corporate resources and necessary to support the continuing investment required to develop and produce future energy supplies… The criteria for investment decisions are essentially economic, but also take into account social and environmental considerations and an appraisal of the security of the investment."*

3. PRODUCT DEMAND AND SUPPLY

Over the past two decades, the demand for petroleum products in the U.S. has risen steadily, due in part to a growing population, falling fuels prices, Americans' preference for heavier and more powerful vehicles, and an increase in passenger and goods travels. In 2005, daily demand for refined products in the U.S. was about 21 million barrels, equivalent to a consumption rate of about 20 pounds of petroleum per person per day. No other commodity in the history of the world has ever been consumed at such levels.

In 2005, the U.S. consumed about 14 million barrels per day (BPD) in the transportation sector, 4 million BPD in the industrial sector, 2 million BPD in the residential and commercial sector, and 1 million BPD in the electric power sector (Figure A.1). Consumption trends by sector for refined products are shown in Figure A.2-A.5.

The U.S. demand for crude oil and petroleum products exceeds its supply (Figure A.6), and so the U.S. imports a variety of intermediate and final petroleum products in addition to crude oil. About 60% of the U.S. petroleum requirements are currently imported, and although the U.S. is still one of the world's largest producers of crude oil, its reserves base is only 3% of the world's proven reserves (British Petroleum, 2005). For the foreseeable future, the U.S. will grow increasingly dependent on imported oil for its needs.

The raw materials and intermediate materials processed at refineries in the U.S. are depicted in Figure A.7. Refinery output is the total amount of petroleum products produced (Figure A.8). About 90% of crude oil in the U.S. is converted to fuel products that include gasoline, distillate fuel oil (diesel fuel, home heating oil, industrial fuel), jet fuels (kerosene and naphtha types), residual fu

4. OIL AND GAS RESOURCES

4.1. Fossil Fuels

Fossil fuels consist of plant and animal remains (organic matter) that have been preserved in rocks. Organic material accumulated in swamp beds and on the bottom of ancient seas hundreds of millions of years ago, and through sediments of sand and mud and conditions of high temperature and pressure, a variety of solid, liquid, and gas hydrocarbon molecules were created, such as coal, oil, natural gas, tar sands, and oil shale. Since the distribution of swamps and ancient seabeds conducive to fossil fuel formation is a function of Earth's plate tectonic and climatic history, fossil fuels are not expected to be evenly distributed in the world.

4.1.1. Coal: Coal is formed from vegetation which grew in swamps hundreds of millions of years ago. Peat deposits were built up as vegetation died and accumulated at the bottom of swamps to form spongy, brown material, called peat. Geological forces buried the peat under the surface of the earth, where the layers were compacted by pressure and heat, causing it to release water and other gases in a process referred to as coalification (Schobert, 2002). Coal formed from the compressed peat. The greater the heat and pressure, the harder the coal; the harder the coal, the less moisture it contains and the more efficient it is as fuel. As coalification proceeds, coal increases in rank from lignite, to bituminous, and to anthracite, increasing in value, heat content, and quality. Lignite is the softest coal and contains the most moisture. Sub-bituminous and bituminous coal are medium-soft and medium-hard coal with less moisture and higher heat value. Anthracite is the hardest coal with the highest heat content and value per ton mined.

The most important factors affecting coal quality are ash, sulfur, and trace elements. Ash is the residue that remains after burning and consists of clay minerals and quartz. Sulfur occurs in various forms and low-sulfur coal is considered to contain less than 1.5% sulfur by weight.

Coal reserves are easy to find and document, and because sedimentary basins are widespread throughout the world and the process to form coal is relatively simple, coal is the most abundant fossil fuel in the world. Coal beds tend to occur close to the surface of the earth, usually within a few hundred feet of the surface.

4.1.2. Crude Oil and Natural Gas: Crude oil and natural gas are derived from fats and other lipids in marine algae and other aquatic plants that were buried with sediment. The organic matter transforms into kerogen, an insoluble material that consists of molecules much larger than those in oil or gas. With burial, pressure and temperature increases and kerogen decomposes to form crude oil and natural gas (Kesler, 1994).

Crude oils are a complex mixture of hydrocarbon molecules of many different sizes and shapes. Each crude oil produced in the world has a unique chemical composition containing distillates of different molecular composition, burning qualities, and impurities such as metals, asphaltenes, nitrogen, and sulfur (Speight, 1991). The main characteristics used to classify hydrocarbons include molecular composition, specific gravity (density), viscosity, color, and other physical properties. Crude oil is a liquid, and because of its chemical composition, is a very compact source of energy that is easily transported.

Natural gas is a mixture of hydrocarbon gases, carbon dioxide, and nitrogen. Methane (CH_4) is the major constituent, followed by ethane (C_2H_6), propane (C_3H_8), butane (C_4

Natural gas is used as a feedstock for petrochemical facilities, by utilities to generate electricity, and by residential and commercial establishments for heating. The demand for natural gas is seasonal for residential consumers and electric utilities. Industrial and commercial demand tends to cycle with the general business environment (U.S. General Accounting Office, 2002; U.S. General Accounting Office, 2006).

4.3. Reserves and Resource Estimates

Oil and gas resources are classified according to proved, probable, and possible categories in the U.S. and proven and possible categories in the U.K. (Gallun et al., 2001). Companies operating outside the U.S. and U.K., National Oil Companies, and private firms employ these and other guidelines in reserves estimation. Reporting conventions vary by country, and often do not comply with the strict definitions required for company reporting by the U.S. Securities and Exchange Commission (SEC).

Proved reserves are estimates of the amount of oil or gas (coal, or other resource) which can be recovered economically using current technologies. Proved reserves is the most certain because it includes only those resources that have at-0.0001 h the smds 0 esao.V).

4.4. World Proved and Undiscovered Reserves

A number of primary and secondary sources report oil and gas reserves and resources. Primary sources mostly include company and government data, while secondary sources such as *World Oil*, *Oil and Gas Journal*,

4.5. Unconventional Resources

Unconventional resources are an umbrella term for resources that are more challenging to extract than conventional resources. Under the right economic and technological conditions, however, unconventional resources are expected to add significantly to future oil and gas supplies. Today, two "unconventional" oil resources are being produced – heavy oil from Venezuela's Orinoco oil belt and bitumen from Canada's tar sands. Unconventional resources also include oil shale, coal bed methane, gas hydrates, and tight gas. Coal bed methane and tight gas are also under active production. Most of the world's known unconventional resources are found in the Western Hemisphere, in the U.S., Canada, and South America.

Unconventional resource estimates typically represent the total resource in place and do not guarantee economic feasibility, and so reserve estimates are more uncertain than conventional resources and should not be compared directly.

4.5.1. Heavy Oil: Heavy oil is oil that will flow under normal reservoir conditions but requires Enhanced Oil Recovery (EOR) techniques for economic production. Heavy oil is typically easier to locate than light-crude pools and occur closer to the surface, but the oil is more difficult and costly to extract, transport, and process. Venezuelan extra-heavy crude is nearly as dense as, or denser than, water and significantly more viscous than conventional crude. Heavy oil deposits are found throughout the world, but the most significant developments are presently confined to Canadian oil sands and the Orinoco belt in Venezuela. The USGS estimates that there are 434 billion barrels of technically recoverable heavy oil throughout the world (Table A.15).

4.5.2. Tar Sands (Bitumen): Oil that will not flow is referred to as tar (or bitumen). Tar can be found in all types of rocks, but tar in sandstones is referred to as tar sands. Tar sands are mined and then mixed with hot water or steam to extract the bitumen, and is then processed in secondary conversion facilities to convert to a material like oil, called syncrude. Most tar stands are currently extracted by strip mining, or by heating or solvating underground deposits and pumping out the resulting oil (in-situ production). Because the majority of bitumen resources are not surface accessible, in-situ production will likely overtake strip mining as operations advance.

There is no exploration risk in tar sands production, and for that matter, no decline curve, but the operation is sensitive to natural gas prices and must have access to sufficient water sources. Large deposits of tar sand are found in the Athabasca area of Alberta, and Canadian and international oil companies are reported to be prepared to spend $87 billion in oil sand development over the next 10 years (Carlisle, 2006). World resource estimates for bitumen are shown in Table A.15.

4.5.3. Oil Shale (Kerogen): Oil shale is shale from which oil can be obtained by processing. Shale oil is mined, crushed, and heated to temperature of 500-1,000°C in a process called retorting. A large quantity of water, anywhere from 2 to 5 times as large as the volume of oil produced, is required in the process. The shale undergoes pyrolsis which releases hydrocarbon gases and liquids. In the 1980s, $5 billion was invested in the U.S. in oil shale projects, but difficult engineering and unexpected economics made all the operations commercial failures. Today, oil shales are not currently economically recoverable, but high oil prices are again reviving interest in this potential resource. The worldwide oil shale resource base is estimated to be 2.6 trillion bbl located across 26 countries (Johnson et al., 2004a and b). The United States is the world leader in oil shale resources with about 2 trillion bbl. The most economically attractive U.S. deposits, containing an estimated 1.5 trillion bbl, are found in the Green River Formation in Colorado, Utah, and Wyoming.

5. OIL AND GAS MARKETS

5.1. Oil and Gas Are Commodities

Oil, gas, and the products of refining – gasoline (aviation and motor gasoline and light distillates), middle distillates (jet fuel, heating kerosene), fuel oil, and other products (refining gas, lubricants, wax, solvents, refinery fuels) – are commodities. Commodities are products that are undifferentiated from a competitor and sold on the basis of price, defined in competitive markets by the intersection of supply and demand curves at a given location and time, and influenced by other factors. Although oil and gas are commodities, oil and gas markets have many unique features.

5.2. Prices Are Determined by Supply, Demand, and Inventory Conditions

Spot prices are determined by supply, demand, and inventory conditions at a given location and time. The most fundamental economic relationship governing commodities

5.3.2. In-Situ vs. Wellhead Prices: The price of a barrel of oil at the wellhead differs from the value of a barrel of oil in the ground because the reserve must be produced and delivered before being sold to a buyer. Production, depreciation, and transportation expenses account for the majority of the price difference. Over the past decade, oil and gas reserves have sold on average at about 22% and 36% of their respective wellhead prices (Adelman and Watkins, 2003; Smith, 2004). In-situ values are also more stable than wellhead prices.

5.3.3. Spot Prices: Spot prices are wholesale prices for physical delivery at a specific transfer point such as a pipeline or at a harbor. Oil spot markets are prevalent worldwide. Gas spot markets are only common in countries where the gas industry has been deregulated, such as the U.S., U.K., Netherlands, and Norway.

The price of natural gas is determined on a regional basis, and so it is not possible to refer to a "world price" for natural gas. In North America, for example, prices respond to demand and supply forces, while in Russia, the state gas company Gazprom holds a monopoly position. In Western Europe and Japan, the sales price for natural gas is based on competition with alternative fuels and indexed on oil product prices. Most of the gas that is traded internationally is in the form of liquefied natural gas (LNG) long-term supply contracts to finance the expensive infrastructure.

5.4. Oil Supply and Demand Imbalance

The main exporters of crude oil are Saudi Arabia (8.8 Mb/d), Russia (6.7 Mb/d), Norway (2.9 Mb/d), Nigeria (2.5 Mb/d), Iran (2.5 Mb/d), and Venezuela (2.4 Mb/d). The main consumers are the U.S. (20.5 Mb/d), Western Europe (14.8 Mb/d), China (6.7 Mb/d), and Japan (5.5 Mb/d). Geographical imbalances between supply and demand create the need for massive exports from the Middle East, the former Soviet Union, and West Africa to the Far East, North America, and Western Europe. In Table A.16, production and consumption statistics provide a "snapshot" of the imbalance that existed in 2004 between the net importers and exporters of oil.

5.5. Oil Markets Are Global, Gas Markets Are Regional

The cost to transport gas over large distances is significantly more expensive[4] than oil, explaining why gas is fragmented into regional markets (Tussing and Tippee, 1995). Three regional markets in gas currently exist: United States – Canada, Western Europe – (Norway, Russia, Algeria), and Japan – (Indonesia, Australia, Middle East). LNG promises to globalize the natural gas industry, but this is still many years away.

5.6. Oil and Gas Prices Are Volatile

Crude oil and gas prices are more volatile than other commodities, reflecting political and economic events, demand, perceptions about resource availability, and many other factors (Pirog, 2005a). The volatility of the oil and gas industry usually makes the timing of policies ineffective, since the system will change before the policies can take effect (U.S. General Accounting Office, 2006). Regions of the world react differently to crude price variations, depending on the level of taxation, demand elasticity, government support, and many other factors.

5.7. Price Spikes

Oil and gas prices are heavily influenced by major system discontinuities, such as war, regional financial crisis, and political intervention. Because of the balance between oil supply and demand, taking even a small amount of oil off the market can cause prices to rise dramatically. Geopolitical problems have always affected the oil industry, but these problems occurred when surplus capacity could offset disruptions in output from one or more regions.

In late 2002, striking workers in Venezuela, followed by continuing disruptions in Nigeria and the U.S.-led invasion of Iraq took several million barrels out of the supply mix. So when Iran threatens to cut off supply in their standoff with the U.S. or as Russia continues to make foreign investment in their energy sector more difficult, the market has a large risk premium embedded in the price of oil.

There are interesting geopolitical implications associated with the price volatility, since rebel groups in Nigeria and countries such as Chad can threaten to disrupt oil supply to gain political support or leverage for their cause (Cummins, 2006).

In Oil Shockwave, it was estimated that a 4% global shortfall in daily supply would result in a 177% increase in the price of oil (from $58 to $166 per barrel). There have been four oil price shocks[5] since the nationalizations in the early 1970s, and the number and magnitude of price up-ticks has increased since 1997 (National Petroleum Council, 2004).

The economic recessions in the United States are often blamed on oil price increases (Hamilton, 1983). Much research has examined the relationship between oil price movements and their effects on macroeconomic activity, and although the findings are

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[4] On an energy equivalent basis, the cost of gas transportation is about 5-10 times higher than oil.
[5] A price spike is defined to be a monthly price increase in crude oil in excess of 10% above the prior year.

widely inconsistent, most studies tend to demonstrate measurable relationships between oil price shocks and aggregate economic activity.

6. DATA SOURCES, DATA QUALITY, AND PROBLEMS OF INTERPRETATION

6.1. Data Sources

Energy is central to U.S. economic activity and prosperity, and so there is a wealth of public data at an exceptional level of detail across all segments of the industry. The quality, accuracy, and quantity of the data are superior to any other industry, anywhere in firms or time due to the nature of the data collection. Spending surveys and cash flow are difficult to assemble on a county-by-country basis, and are usually only available on a regional or global level with a high level of noise due to the survey methodology (survey vs. public records), coverage (sample size), instrument specifications (aggregation, categorization, etc.), and other factors.

Public records can be used to review a company portfolio of assets and the manner in which capital is allocated across business sectors as a function of time. Public information does not include the risk-reward profile of projects, however, corporate risk profiles, or risk-adjusted[6] discount rates.

6.3. Problems of Interpretation

The oil and gas industry is far too complex and dynamic for simple cause and effect expenditure surveys, for example, segments of the business are typically presented according to upstream and downstream sectors and decomposed along a company, country, region, or world basis. If any one sector (e.g., exploration and production) is analyzed in isolation from other business activities, the system will probably be misspecified. Oil and gas streams are frequently combined in terms of a BOE-basis, which will introduce additional uncertainty, since oil and gas streams are not identical on a heat-equivalent basis and have been valued quite differently over time. Aggregation generally "smoothes out" uncertainties, but the process may lead to misspecification or bias, or both (Lynch, 2002). Finding costs and reserve replacement ratios, for instance, are particularly poor metrics when computed on an aggregate basis.

6.3.3. Omitted Variables: System behavior and trends are explained through measurable/observable factors, which imply a correlative relationship and predictive ability, but relations may be spurious due to omitted variables. The factors that affect demand and supply, capital investment and country competitiveness are determined by economic principles and commonly accepted industry notions, but there is no general analytic framework that can accommodate all the potential interacting factors. Individuals will likely disagree on specific factors, their specification, relative importance, level of aggregation, and causality. Since there are so many potential factors, it is unlikely that a factor set will suffice in explaining all aspects observed.

6.3.4. Factor Types: Factors may be observable or unobservable, deterministic or stochastic, one- or

7. FACTORS THAT IMPACT SUPPLY AND DEMAND

The supply of oil in the world at any point in time is the sum of the production levels achieved by the collection of many private, public, and state-owned companies. Each individual producer plans for and decides on its own supply level independently, with the exception of OPEC members, and possibly, short-term "alliances" that may form during exceptional times; e.g., extreme price levels, military activity, etc. For the members of OPEC, the level of supply results from the coordination and collective decisions of the member nations. The goals, strategies, and behavior of private and public companies vary widely, but investment decisions for companies tend to be based on profitability criteria, the companies' cash flow position, and its outlook for the future. International oil companies have shareholders who require a return on their investment. The goals, strategies, and behavior of state-owned companies on the other hand are much more diverse. National oil companies have domestic social and political obligations, the need to create foreign exchange, and the desire to exert geopolitical influence.

The demand for oil and gas begins at the individual and corporate level. Individuals drive cars; heat and cool their homes, and consume food and other services, all of which require – either directly or indirectly – oil, gas, and petroleum products. Corporations provide goods and services which also require energy. Aggregating the individual, commercial, and industrial demands of a nation comprise the demand function for the country.

7.1. Economic Activity

Energy availability and consumption play a key role in the process of economic growth, and conversely, is an essential input into technological advancement in the substitution of machines and other forms of capital for human labor. Energy use is a necessary input to economic growth and is also a function of growth.

Energy use is associated with population growth, the expansion of urban centers, industrialization, and the development of infrastructure such as roads and transportation networks (Chima, 2005). It takes energy to produce things of value, and thus, there is typically a strong correlation between a country's energy consumption and economic activity as measured by gross domestic product[7] which will potentially slow the rate of GDP growth and limit energy consumption (Pirog, 2005a). In China, these same forces are at play as expanding exports increase the industrial demand for oil, and rising consumer income has increased consumers' demand for gasoline. For countries whose oil exporting sector is a major component of their GDP (e.g., Russia, Nigeria, Saudi Arabia), the expansion of the oil sector is itself likely to lead the growth in GDP[8].

7.2. Inventory

The expectation that oil and refined product inventories influence prices is based on the assumption that prices reflect the current supply/demand balance, and that inventories provide a measure (albeit imperfect) of the changing balance between supply and demand (National Petroleum Council, 2004). Any factor that serves as a measure of the short-term supply/demand balance would be expected to influence prices, but the impact will vary depending on the market perception of the importance of the factor, how fast the information flows to the market, and other conditions at the time of observation. An NPC study found only a modest correlation between inventory levels and crude oil price (National Petroleum Council, 2004). The U.S. Department of Energy (DOE) found a slightly stronger relationship when total crude and product inventories, recent inventory trends (lag terms), and relative inventories measured by actual inventories versus "normal" inventories defined by seasonal trends were included (Ye et al., 2003). A relationship between inventories and the shape of the forward price curve exists, with inventories positively correlated with the forward price spread.

7.3. Price

Price is by far the most accessible and reliable data series available, and thus, is a preferred explanatory variable for supply and demand forecasting. Crude oil price is determined in the world market and depends mainly on the balance between world demand and supply. Markets respond to supply/demand changes with price movements that provide the incentive to increase or decrease supply to correct imbalances (Adelman, 1993; Seba, 2000). High prices lead to increases in exploration and development budgets, and as new oil and gas is found and brought to the market, supply increases and prices are typically reduced. High prices can also make alternative fuels more competitive, potentially reducing demand, and are likely to encourage conservation, further reducing demand.

7.4. Geopolitics

Geopolitical shifts and foreign policies play an important role in global energy security and long-term energy supplies. The fall of communism and the liberalization of

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[8] For countries where oil and gas comprise a large part of total export revenue, economic downturns are more likely when oil markets shift. It has been observed that countries with significant oil reserves often end up with low growth rates because they are less willing to adopt restructuring and can afford to shun foreign investment and basic economic criteria in decision making (International Monetary Fund, 2004; Karl, 1997).

economies in Asia and South America have opened vast energy resources previously inaccessible or underdeveloped, while China and India's growing concern about the rising cost of energy and their dependence on import oil has prompted their state-owned companies to aggressively seek acreage and investment opportunity throughout the world, often through aggressive bidding and in regions with high political risk. China's demand for steady supplies of oil is reshaping the global energy market, the environment, and world politics (Obaid et al., 2002; Wonacott et al., 2003; U.S. Congressional Budget Office, 2006). India is next in line, as its government will try to achieve a better lifestyle for its population.

Market reforms in a country will usually improve production and encourage foreign investment, while nationalism will typically lead to reduced investment, at least in the short term (Kennett and Goswami, 2006). A growing number of countries across South America, for example, are opting for more nationalist, left-leaning governments (e.g., Bolivia, Ecuador, Venezuela) as opposed to the market-oriented policies of previous moderate, socialist governments. Throughout Africa, South America, and the Former Soviet Union, governments and their NOCs are renegotiating contracts to take in more revenue via taxes and royalties (Coburn, 2005). In the 1990s, Russia divested itself of some off its biggest industrial assets in often-controversial privatizations. Since 2002, the Kremlin has sought to regain control of the energy sectors. State-owned energy companies OAO Gazprom and OAO Rosneft, for example, have purchased independent oil producers, OAO Sibneft and OAO Yukos. Iran continues to feud with the West over its nuclear ambitions, and continued conflict in Nigeria maintains a risk premium in the price of oil.

Geopolitical events can create pressures in either direction, with both short and long-term consequences, and it is easy to overstate their influence and underestimate their effect. Geopolitical events by their nature are impossible to predict (Mitchell, 1996; Mitchell et al., 2001).

7.5. Geology

The geology of a country or province will ultimately determine the energy supply potential of the region. There is a finite amount of oil and gas resources in the world, but whether we ever extract all of the resource or develop oil reserves depend on host country policies on foreign investment, depletion rates, and environmental protection. By the mid-1990s, many countries had at least partially opened their oil sector to foreign investment, but three major oil-producing countries still remain totally closed – Kuwait, Mexico, and Saudi Arabia. Investment in Russia, China, Iraq, and Iran remain constrained by regulatory, political, and administrative barriers and delays (International Energy Agency, 2003).

7.7. Technology

Technological advances in the oil and gas industry have been phenomena over the past two decades. Vastly increased computing power has stimulated the development and interpretation of geophysical data, which has led to a better understanding of reservoir characteristics. Progress in 3-D and 4-D seismic techniques, advances in deepwater exploration, horizontal drilling, multiphase pumps, floating production storage and offloading vessels, have all made a contribution to increasing supply. It is widely recognized that technological advances have improved drilling productivity and recovery rates and reduced production costs, especially offshore and in frontier areas, but its impact is difficult to isolate. Technological advances raise the proportion of a field which can be economically recovered, while improvements in infrastructure allow smaller and/or deeper fields and less productive wells to be economically produced. Improving technology will continue to make more reserves available.

7.8. Exchange Rates

World oil is priced in dollars and transactions are settled in dollars, and so changes in the exchange rate of the U.S. dollar can affect the level and distribution of oil demand in both directions. The effect of a declining dollar depends on the import/export status of the nation and how the currency of the country adjusts to the cha tn id

(11%), Iraq (10%), Kuwait (8%), UAE (8%), and Russia (6%) also control significant quantities of proved reserves and have mostly limited foreign investment in the sector. National Oil Companies are expected to have a substantial, long-term, and growing impact on the pace of resource development, market stability, and geopolitics.

There is a wide diversity in the structure of NOCs. Prior to 1960, most NOCs formed around specific local issues and the desire for self-sufficiency, while during the 1970s, many countries nationalized their assets to regain control from foreign companies and achieve higher rents from production. In the 1980s, after oil was commoditized and price volatility and falling prices negatively impacted profitability, oil ministries and NOCs began to restructure to increase their efficiency and return on capital standards were increasingly employed. In the 1990s and post-2000, countries with economies in transition reorganized their oil ministries to form NOCs and private firms (Jaffe, 2005; National Oil Company Case Study Research Protocol, 2005).

Economic liberalization, market reforms, and western-style management reorganizations have characterized the oil and gas industries of major energy producing countries such as Russia, Norway, Canada, and Malaysia, as well as major consuming countries such as China, Brazil, Japan, and India. National Oil Companies are in the process of re-evaluating and changing business strategies with significant consequences for international majors and market stability.

7.13. Exceptional Events

War, riots, political instability, natural disaster, and terrorism impact the supply and demand for oil and gas. Exceptional events by definition are unique and impossible to predict. The impact of exceptional events on oil and gas markets has potential short-term and long-term consequences, depending on the state of the world oil market at the time of the event. Some notable examples of exceptional events from 2001-2005 include:

- War in Iraq,
- Terrorist attacks in New York, Saudi Arabia, and elsewhere,
- Political unrest and riots

Discontinuities impact the ability to forecast supply and demand trends over time (Lynch, 2002; Stevens, 2000 and 2001). When discontinuities occur, the future will be fundamentally different and historic trends significantly disrupted. System discontinuities are therefore frequently ignored in analytic models, but such impacts are integral to the nature of the system. The further into the future a forecast is made, the larger and more frequent potential discontinuities will arise.

7.14. Market Manipulation

The primary markets in oil price formation are NYMEX and the International Petroleum Exchange. The goal of financial traders is to make a profit on changes in the price of a contract, which necessitates creating price movement, regardless of the supply-demand fundamentals of the market. Market manipulation may impact price formation and the signals governing the supply-demand balance.

7.15. Government Policy

Government policy takes many forms and can have a direct impact on supply and demand and investment patterns. Each nation domestic production by stable fiscal regimes and tax incentives. Producing exporting countries will try to secure the maximum

8. FACTORS THAT IMPACT E&P INVESTMENT

In the E&P industry, many factors influence drilling and development decisions and the manner in which a company allocates capital across its portfolio. A firm should seek to maximize profits, but financial forces and shareholders (banks, f

8.1.2. Share Purchases: A company that re-purchases its shares will likely see the value of the shares outstanding increase. The company may then choose to re-sell their shares on the market if it needs capital in the future.

8.1.3. Debt Reduction: Banking institutions are an important source of funds to the oil and gas industry, but generally cost more than other forms of financing. Most companies rely on banking for short term borrowings such as a line of credit, revolving credit agreement, transaction loan, or dedicated cash operating income payment.

8.2. Availability of Capital

If the capital employed in a company does not generate an adequate return, the company will have limited access to new capital, as investors and lenders seek more profitable opportunities elsewhere. The availability of capital is not expected to be a constraint to investment for integrated oil and gas companies in the short-term, however, because of the return on investment (ROI) for the sector over the period 1993-2002 has been high for publicly traded companies in the Organization for Economic Cooperation and Development (OECD) and non-OECD regions (Figure A.12). Integrated companies realized the highest return (12%) across various industries, while the ROI of independent companies in E&P was 6.3%, the lowest for all industry sectors.

8.3. Budget Allocation

Oil and gas companies will expand and upgrade various aspects of their operations, such as refining, petrochemicals, marketing, and transportation, at various times depending on the strategic rationale of the company. Companies may also diversify into other industries such as mining or non-energy related activities. The degree of vertical integration affects the degree to which capital is allocated across the various segmep01i4he lo the correlation between price and capital expenditures is likely to be weaker and more closely dependent upon the nature of the field developments, project size, time lags, planning horizon, and other unobservable variables. High prices tend to lead to increases in company exploration and development budgets, and if the current market follows past patterns, increased activity and expansion of supply.

Price enters the drilling decision through the calculation of the potential payoff associated with a play. High prices stimulate drilling decisions, because the economic and reward structure appear more favorable. When prices drop, companies are inclined to curtail some of their exploration activity, and if prices stay low long enough, companies will shut-in high-cost wells, delay development activity, and postpone high risk ventures. At low commodity prices, M&A activity is usually more prevalent, with majors selling properties and shifting their budgets to regions/activities with a greater return. Strong prices will tend to delay divestiture programs, since properties that are marginal at low prices become profitable. In recent years, as demand-side NOCs have begun to secure reserves for their host country through high-cost acquisitions, these relations may change.

8.6. Oil Price Volatility

Oil and gas investment has tended to fluctuate with oil prices, especially in recent years, but the relation is not a universal phenomenon and several other factors are involved. A careful examination of the historic record indicates that capital spending in E&P may increase or decrease when the price of oil increases. A price collapse will typically lead to a reduction in investment spending, although the magnitude will vary depending on several other (unobservable) variables. High prices tend to encourage investment spending, but the life cycle of exploration and development means there is a several year delay. Price uncertainty will raise the option value of future investments and firms are likely to postpone or reduce expenditures on irreversible investments. IEA analysis has found support for an inverse relationship between upstream oil investment and price volatility (International Energy Agency, 2003).

8.7. Merger and Acquisition Activity

If a company is under merger, acquisition, or reorganization this will typically slow down or delay capital spending. Corporate mergers in which one company acquires another companies total assets impact exploration and development decisions. M&A activity may

8.9. Business Uncertainty

Investment decisions in capital intensive and high risk industries such as E&P tend to be based on full-cycle project economics, expected long-term prices (Boudreaux et al., 1999; Wehrung, 1989), portfolio decision-making (Edwards and Hewett, 1995; Hightower and David, 1991), and strategic rationale (Seba, 2000). Capital requirements in E&P compete with other segments in the petroleum industry as well as the capital needs of other industries. Uncertainty about the future price of oil and gas and global conditions impacts allocation decisions and external evaluations by bond raters and capital markets (Pirog, 2005b).

The higher profitability of integrated oil and gas companies relative to independents and service companies (recall Figure A.11) reflects the nature and diversity of their assets and operations. The volatility of ROI by industry is depicted in Figure A.12. Exploration and development and service companies have a volatile ROI, while the volatility of integrated companies is comparable to the chemical industry. For decisions that require a large amount of capital, increased uncertainty tends to slow down or stop investment in order to reduce risk. Uncertainty over regulations and license rounds would also be expected to lead to reduced capital investments.

8.10. Capacity Constraints

The E&P industry is composed of many diverse companies and resource constraints which are likely to vary widely among individual companies and regions of the world. E&P projects are designed and engineered by a combination of internal company resources and third-party companies, ranging in size from small engineering firms to multi-billion dollar companies. The support equipment and services required (e.g., rigs, vessels, personnel, materials) to successfully execute an E&P project is driven by supply and demand forces at a particular place and time, and has not historically been a significant constraint to project implementation. There is evidence to indicate that reduced capital spending by oil-services companies, which result in less availability of oilfield equipment, has at times forced oil and gas companies to scale back their investment programs (International Energy Agency, 2003), but the impact is usually short-term because an increase in demand will increase dayrates[9], which will stimulate new investment, increasing supply and competition, and balancing the market.

8.11. Resource Availability

Oil and gas companies create value by investing in those projects for which the market value of cash inflows exceeds the required investment outlays. The purpose of drilling is to discover reserves, but it costs money to identify plays, acquire and interpret seismic data, and drill wells. If the resources found are not adequate to make a sufficient return on capital, then the E&P industry in the region will drop and shift investment where the return is acceptable. If the region is not prospective, or if the NOC controls the best

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blocks, then foreign capital will eventually diminish and move to other regions or business opportunities.

8.12. Risk Strategies

Investing in energy projects in developing countries and the transition economies is generally riskier than in OECD countries because of institutional and organizational reasons; lack of clear and transparent energy, legal, and regulatory frameworks; and poorer economic and political management. There is also a significant difference in the risk and return profile between an export project and a project for the domestic market in non-OECD regions. Risk strategies and the means to manage risk vary with each company.

8.13. Government Policy

Governments choose their production capacity potential based on a number of factors. OPEC producers, for example, may determine that curbing investment and limiting capacity would boost net earnings from exports. OPEC producers also recognize the risk that other producers (OPEC or non-OPEC) might boost their capacity more quickly, resulting in lower export earnings for the country. Governments might defer investment to preserve hydrocarbon resources and revenues for future generations (Reynolds, 2005). This could be a legitimate policy for a country with relatively high GDP per capital and no pressing need for additional oil revenue to fund infrastructure or social programs. If governments increase taxes and royalties on production, or otherwise change the terms and conditions of the fiscal regime, lower profitability of upstream projects might deter investment.

8.14. Exogenous Variables

Numerous external factors also play a role in the amount of capital a country can invest in its oil and gas sector (International Energy Agency, 2003):

- If a country's national debt is high and there is a need to borrow large sums to finance new projects, investment may be delayed.
- National sovereignty might discourage reliance on foreign investment.
- Legal and commercial terms and fiscal regimes impact how much external capital producers are able to secure.
- In many countries, education, health, defense, and other sectors of the economy may command an increasing share of government revenues and constrain capital flow to the oil sector.
- Inadequate infrastructure to support oil and gas development, insecurity, and conflict could constitute additional barriers to investment.

9. E&P EXPENDITURE TRENDS

Exploration and production activity cannot be explained solely on the basis of geology. Politics, economics, technology, regional and global markets all act to preclude, foster, or inhibit E&P activity and capital investment. E&P activity varies with a country's demand for crude oil and natural gas within its border, as well as the desire to export oil and gas as a means of gaining foreign exchange. When

9.1.1. Return on Equity: The return on stockholders equity for the FRS companies varies considerably from year-to-year and has fluctuated with the S&P Industrials (Figure A.13). Oil and natural gas production was the most profitable segment of the business ($59 billion), followed by refining/marketing ($22 billion), and non-energy activities ($4 billion).

The return on net investment is defined as the net income earned by the line of business (excluding unallocated items such as interest expense) as a percentage of net fixed assets. The return on net investment for domestic oil and natural gas production operations has exceeded foreign operations in recent years (Figure A.14), whereas prior to 1995, the returns from foreign operations dominated.

9.1.2. Sources and Uses of Cash: The sources and uses of cash for FRS companies are shown in Table A.19. Cash flow from operations amounted to $136 billion in 2004, with oil and natural gas production comprising 65% of the total. At significantly smaller levels, cash was also raised through disposal of assets, long-term debt, and equity security offerings.

Cash flow is a primary determinant of the level of capital investment, ranging anywhere between 15-40% of net income in a given year (Beck, 2004). In 2004, the largest use of cash was for capital expenditures, which increased 8% to $86.5 billion (Table A.19). Petroleum activities accounted for 86% of capital expenditures. Dividends to shareholders were the second largest use of cash, followed by reduction in long-term debt and stock repurchase.

9.1.3. Capital Expenditures: Capital expenditures for exploration[10], development, and production generally follow changes in cash flow, except most recently in 2004, where a wide differential resulted (Figure A.15). A positive change in oil price is usually associated with a less moderate but positive change in cash flow, while a negative change in oil price is often correlated with a zero or negative change in cash flow. In Figure A.16, worldwide expenditures are broken out according to exploration, development, and production activities.

Regionally, the U.S. onshore continues to receive more E&P expenditures than any other.0008 Tc0f

Anderson (now Accenture), and other financial institutions perform similar surveys. Government agencies that perform capital expenditure reviews and outlooks include the Energy Information Administration (EIA), International Energy Association (IEA), and Institute of Petroleum (IFP). Consultancies such as IHS, Ziff Energy, Wood MacKenzie, Douglass-Westwood, and trade publications such as *The Oil and Gas Journal*, *American Oil and Gas Reporter* (O&GJ), and *World Oil*, also conduct annual capital spending surveys.

The surveys typically cover issues such as:

- Expected spending plans for the upcoming year, by region (U.S., Canada, international), activity (upstream, downstream, business segment), and company type (majors, independents, NOCs);
- Perceptions on expected changes in service and drilling costs, merger and acquisition activity, oil and gas price assumptions, availability of prospects, availabilities of drilling services, impact of technology on spending plans, remaining reserves expected to be found, human resource issues, compensation for technical staff; and
- Perceptions on the relative attractiveness of investment opportunities (exploration vs. development, U.S. vs. international, drilling vs. acquisition activity, oil vs. gas plays), expected operating cash flows, spending plans (leasing, seismic, onshore vs. offshore).

Significant variations in the manner in which data is compiled and processed make it difficult to compare survey results. In Table A.21, for example, global upstream oil and gas investments for four surveys are compared from 1995-2002. Wide variation exists, Europe, are either mostly unavailable (Middle East, Africa) or available in incomplete form (Asia Pacific). Worldwide investment in E&P has tended to follow the price of oil, especially in the years prior to 1998, but the correlation is noisy and dependent upon the data series employed. When the price rises or falls, exploration budgets adjust quickly to the changes, while development budgets tend to be delayed. Some regions of the world react faster to price variations than others, with North America generally considered to be the most price-sensitive.

After the nationalizations in the 1960s and 1970s, the majors needed to redeploy capital throughout the world to access acreage. Exploration and production budgets matched the price shocks of 1973 and 1979 as demand growth increased. From 1981-1987, prices suffered as excess supply developed from the previous investment boom. Capital expenditures were reduced and prices retreated. From 1987-1998, prices stabilized below $25/bbl and a more cautious approach to investment was realized. Following the price collapse in 1998, capital expenditures took a temporary fall before continuing on an upward slope.

9.4. IEA Investment Forecast

The IEA predicts that an investment of over $3 trillion, or $103 billion per year, will be needed in the oil sector through 2030 to permit an increase in oil supply to 120 million BPD by 2030 (International Energy Agency, 2003). Exploration and development is expected to dominate the investment, accounting for over 70% of the total. Investment in non-conventional oil projects in Canada and Venezuela is expected to account for a growing share of total upstream spending. Offshore fields are expected to account for about a third of the increase in production from 2002 to 2030, but will take a larger share of investment, because the unit costs are higher compared to other developments.

9.5. Lifting Costs

Lifting (production) costs represents the costs to operate and maintain wells and related equipment and facilities after hydrocarbons have been found, acquired, and developed. Lifting cost is a reliable and meaningful measure, and can be compared across companies if a common accounting framework is applied. Lifting cost is a measure that may be used to evaluate the extent to which a company can control its operating costs and/or how efficiently the company is getting oil and gas out of the ground. Two mechanisms are responsible for boosting productivity and reducing lifting costs: technical progress and industry reorganization.

Total lifting costs are divided into direct costs and production taxes. Direct costs tend to be correlated to the price of oil since increases in oil price tend to bring an increase in the cost of service and supply costs. Production taxes may also be a function of the price of oil and other factors, especially under Production Sharing Agreements.

For the FRS companies, Canada and the Western Hemisphere region have the lowest direct lifting costs in the world, while the Former Soviet Union and Eastern Europe have the highest direct lifting cost (Table A.24). This is likely due to a combination of political systems, technical progress, and industry organization. Direct cost in the U.S. offshore lies between these extremes. Domestic and foreign direct lifting costs are nearly identical and have trended together for the past decade (Figure A.19).

9.6. Finding Costs

Finding costs is one of the most frequently cited ratios utilized in evaluating the efficiency of a company in adding new reserves. Finding costs is also one the most

10. IMPLICATIONS OF EXPECTATIONS ABOUT FACTORS AFFECTING CAPITAL BUDGETING AND DECISION MAKING FOR THE OCS GULF OF MEXICO

Keeping in mind the caveats and qualifications outlined in the previous sections of the report, the following tables attempt to use the format developed to relate "conventional expectations" concerning those factors to future investment trends in the OCS Gulf of Mexico. The "conventional expectation" is a subjective characterization by the authors of the perceptions, opinions, and analyses prevailing among those that follow the oil and gas industry. Our characterization, as well as the perceptions, opinions, and analyses we offer, may be neither complete nor accurate. We may also err in drawing our characterizations. In any event, the reader can form his own thoughts in the matter. Alternative characterizations can be substituted and alternative implications derived at the reader's discretion. The tables are simply a way to relate the implications of the complex and interrelated factors outlined in the previous sections of the report for the Gulf of Mexico region.

Table 1

Factors that Impact Supply and Demand

FACTOR /REPORT SECTION	CONVENTIONAL EXPECTATION	IMPLICATIONS FOR INVESTMENT IN THE OCS GULF OF MEXICO
7.1 Economic Activity	Rapid growth in most populous developing countries, resumption of growth in Japan and Europe, and average or above growth in the U.S. will keep global petroleum demand increasing faster than in the previous two decades. Although global or regional recessions could always slow or stop growth, the impetus for growth seems widespread and resilient to political and cultural disputes and conflict.	Growth in demand is the factor responsible for the expectation of continued higher oil and gas prices, which is an important driving force for investment in relatively high cost areas like the GOM.
7.3 Price	Demand growth will continue to strain available supply capacity and prices are likely to stay at current high levels or increase.	High prices are the key to the economic vitality of GOM investments. The expectation of their continuation makes investment in domestic oil and gas production

Table 1 (continued)

Factors that Impact Supply and Demand

FACTOR /REPORT

Table 1 (continued)

Factors that Impact Supply and Demand

FACTOR /REPORT SECTION	CONVENTIONAL EXPECTATION	IMPLICATIONS FOR INVESTMENT IN THE OCS GULF OF MEXICO
7.11 OPEC Policy (Cont.)		principal, long-term downside supply risk to prices.
7.12 Role of National Oil Companies	National Oil Companies (NOCs) are more subject to geopolitical considerations and less driven by conventional commercial objectives. Coupled with the Russian retrenchment and aggressiveness by the Chinese, risks of large investments in exporting or in transitional economies may have increased.	Relative investment attractiveness of GOM is increased.
7.13 Exceptional Events	Political instability and uncertainty appears to be spreading rather than moderating.	Vulnerability of deep water operations to major hurricanes and new regulatory requirements to deal with them are the principal new uncertainties associated with GOM investment.
7.15 Government Policy	Political instability in Persian Gulf and Africa, nationalism in South America, economic retrenchment in Russia, and the uncertain path of evolution of the FSU countries reduce the certainty and reliability of current government policies and institutions.	The royalty relief controversy and the potential for the resurrection of some form of excess profit taxation are potential direct uncertainties in the GOM, but neither is of the scale of those in many exporting countries. Climate policy and carbon taxes are longer range uncertainties. Shorter-term uncertainty exists in the GOM about new regulations to address problems observed during Katrina and Rita.

Table 2

Factors that Impact E&P Investment

FACTOR /REPORT SECTION	CONVENTIONAL EXPECTATION	IMPLICATIONS FOR INVESTMENT IN THE OCS GULF OF MEXICO
8.1 Financial Performance	Mega-majors and large integrated	

Table 2 (continued)

Factors that Impact E&P Investment

FACTOR /REPORT SECTION	CONVENTIONAL EXPECTATION	IMPLICATIONS FOR INVESTMENT IN THE OCS GULF OF MEXICO
8.3 Capital Budget Allocation (Cont.)	Refining has to some degree been spun off to specialized refining companies and neither they nor the traditional integrated companies exhibit much enthusiasm for investing in new refineries.	
8.4 Business Opportunities	Limitations on access to domestic reserves and increased risks associated with NOCs and transitional economies are as likely to intensify as moderate.	Some FRS companies will seek non-oil and gas business opportunities, but their business culture has not transferred well in the past. Oil and gas will remain their core business and non-US/Canada oil and gas opportunities have become riskier. Stockholders may push for more aggressive, non-oil and gas investments if dividends fall because earnings are invested in financial assets.
8.5 Oil Price	Expectations that prices will remain at or above current levels is a major change in the fundamental investment parameter for investor-owned oil and gas companies. There is considerable variation in estimates of how capital budgets will reflect this change in economic fundamentals, but standard project decision practices will make many marginal projects now profitable.	With current prices twice or three times as high as they were when projects were implemented, GOM profits are correspondingly higher than anticipated.
8.6 Oil Price Volatility	Demand-driven, much-higher, prices imply a much smaller risk of a precipitous decline in prices than has been assumed in the previous two decades.	Expectations that price volatility has diminished shifts the relative balance of risks away from economic and cost factors and toward the geopolitical, non-economic side. As a higher cost but politically and institutionally stable area, the attractiveness of

Table 2 (continued)

Factors that Impact E&P Investment

FACTOR /REPORT SECTION	**CONVENTIONAL EXPECTATION**	**IMPLICATIONS FOR INVESTMENT IN THE OCS GULF OF MEXICO**
8.6 Oil Price Volatility (Cont.)		the GOM is enhanced by this shift.
8.7. Merger and Acquisition Activity	The major industry consolidation and corporate restructuring among the majors during the past decade was driven by the need to be large enough to compete internationally and deal with NOCs effectively. Although size may address commercial risks it is not as effective in mitigating geopolitical risks which have been increasing rapidly. Post-merger adjustments, and their accompanying conservatism with respect to capital spending, have been completed by the mega-majors. Mergers and acquisitions among independents remains active as has historically been the norm.	More FRS companies are large enough to accommodate the progressively larger investments required to develop large projects in deeper water in the GOM.
8.8 Debt/Equity Position	Debt-to-equity ratios of the FRS companies fell to 45 percent in 2004 which is below the average for Standard and Poors (S&P) Industrial Companies. Coupled with substantially increased holding of Treasury bills and cash, this reinforces the expectation that oil and gas companies will have more capital available than has historically been the case as long as prices stay high. According to surveys of independents expectations, neither debt nor capital availability were among the factors they expected to limit capital spending.	Reinforces expectation that capital

Table 2 (continued)

Factors that Impact E&P Investment

FACTOR

Table 2 (continued)

Factors that Impact E&P Investment

FACTOR /REPORT SECTION	CONVENTIONAL EXPECTATION	IMPLICATIONS FOR INVESTMENT IN THE OCS GULF OF MEXICO
8.11. Resource Availability	U.S. moratoria and explicit limitation by NOCs or governments limit investment opportunities. There are some indications of a weakening of the moratoria coalition in the U.S. because of state-level budget needs, but major changes are not expected in non-U.S. areas in the current high-price environment. Aspirations for economic improvement in developing and transitional economies remain strong and create pressure to find and develop resources.	Resource limitations make access to resources in the GOM relatively more attractive.
8.12. Risk Strategies	Risks in non-OECD countries are higher for political and institutional reasons. There are few indications are that this disparity will diminish and many expect it to widen because of geopolitical and nationalistic trends and influences.	U.S. political and institutional stability is a major advantage of GOM investments.
8.13. Government Policy	Major uncertainties and risks will remain in the non-OECD countries—especially in the Persian Gulf, South America, Africa and the transition economies.	Although regulatory policy, access to publicly owned reserves, royalty-relief, and similar issues remain, in a global perspective, governmental policy is of much less concern in the GOM than elsewhere.

The global circumstances confronting those making capital budgeting and investment

11. COUNTRY COMPETITIVENESS

The oil and gas industry is far too complex and dynamic for simple cause and effect relationships to be developed to explain the nature of a country's fiscal regime. The structure of fiscal regimes depend upon many interdependent non-causal factors such as the reserve base and economic strength of the country, oil supply balance, oil prices, evolution of political systems and historic relationship between the industry and the country, field maturity and development stage, regional demand, the country's desire for foreign capital, geopolitical motivations, and many other variables. Countries with low exploration risk and high prospectivity are generally expected to take a high proportion of economic rent, while countries with high exploration risk and low prospectivity must usually offer a larger share of rent to encourage investment.

11.1. International Petroleum Arrangements

The economics of the upstream petroleum business is complex and dynamic. Each year anywhere between 25-50 countries in the world offer license rounds, 20-30 countries introduce new model contracts or regulations, and nearly all countries revisit their tax laws during their annual budgetary process. Typical (or "average") country or regional contracts do not exist, and the terms and conditions of most contracts are proprietary, and at best, partially observable.

There are more fiscal systems in the world than there are countries because

11.1. Intern

- Numerous vintages of contracts may be in force at any one time
- Countries typically use more than one arrangement in license rounds, and
-

11.2. Contract Types

In order to convert mineral assets into financial resources, a government must attract investment capital to explore for, develop, and produce its natural resources. Many styles of contracts govern the arrangements between Host Government (HG) and International Oil Company (IOC) engaged in E&P activity. These arrangements have evolved over many decades in response to political, economic, technical, and geologic conditions. Today, there are essentially four basic types of E&P contracts:

- Concessionary (Royalty/Tax),
- Contractual (Production Sharing Contracts),
- Participation Agreements, and
- Service Agreements.

Each arrangement provides for different levels of control to the IOC, for different compensation arrangements, and for different levels of NOC involvement. Many contracts share elements from one or more categories.

Royalty/Tax systems allow the title to hydrocarbons to transfer to the IOC, while under a contractual system, the HG retains title to the mineral resources and maintains closer control of the management of the operation. Participation agreements create a joint venture between the HG and IOC through the NOC as partner. In a service agreement, a company agrees to perform a service for a monetary payment. Service agreements rarely include a right to share in production, and outside Mexico and the Middle East, are not popular for E&P activity. Royalty/Tax and Production Sharing Contracts (PSC) are the most common agreements in use today.

11.3. Exploration Market

The market for exploration acreage is competitive, finite, and nonhomogenous. Governments offer exploration acreage through formal competitive bidding rounds or through individual negotiation. The market for acreage follows supply and demand fundamentals with demand expected to follow the price of oil and the cash flow position of industry. The supply of acreage has increased over the past two decades as countries outside the Middle East have opened up new areas for exploration, especially on their continental shelves. The amount of acreage available for E&P is also finite and determined through national jurisdiction. The quality of acreage is not homogeneous, however, and different regions have different "prospectivity," depending upon geologic, fiscal, legal, and political factors.

11.4. Capital Market

Governments compete for E&P capital in much the same way that companies compete to acquire exploration acreage. Governments compete on a regional and (to some extent) international basis with other countries to attract capital, while companies compete on a regional and international basis with other companies, and increasingly, NOCs to acquire acreage. Investment capital flows to regions under the influence of complex economic, historic, political, and strategic factors governed by perceptions of risk and return and constrained by the objectives of the contractor and the prospectivity of the country. When countries compete, the share of economic rent may become depressed, while when companies compete, profit margins are likely to be impacted. Countries may offer favorable terms to companies to compensate for other factors, such as an unattractive investment environment or high political risk, or may be inclined for political reasons to favor strategic partnerships for geopolitical influence.

12. FISCAL SYSTEM FUNDAMENTALS

12.1. Economic Rent

Economic rent refers to the difference between the market price of a commodity and the opportunity cost in supplying the commodity (Dam, 1976; Johnston, 1994; Seba, 2000), or as the difference between the value of production and the cost of extraction, where the cost of extraction includes the exploration, development, and operating costs; the cost of capital; and a risk premium (Barnett and Morse, 1963; Kemp, 1987; Mommer, 2002a).

Governments attempt to capture as much economic rent as possible through the terms of the fiscal regime and taxation structure. There are many ways to extract rent, but none of the arrangements is inherently more profitable than any other, and in theory all petroleum arrangements can be made fiscally equivalent by adjusting the contract parameters. Once the requirements of the structure for the fiscal regime and local law have been identified, the negotiating skills and strategies of the parties involved (oil company and host government) become a significant determinant of the final contract terms. Oil companies were once in a privileged position negotiating with inexperienced foreign governments; today host countries are experienced, knowledgeable, and well-educated regarding what the market will bear.

12.2. Oil Company and Host Government Objectives

Countries compete to attract foreign investment and seek to maximize the wealth of its natural resources, while companies seek to build equity and maximize shareholders' wealth. Most countries compete regionally, while oil companies and NOCs compete globally. The motivation of any development agreement is the generation of capital and the development of infrastructure. Governments have an obvious economic interest to obtain the most beneficial terms, but also must make adequate account of negotiated provisions to constituents. Host governments negotiate agreements to accomplish objectives, such as provide a fair return to the state and industry, create healthy competition and market efficiency, and maximize the revenues related to production.

12.3. Fiscal Regime

The fiscal regime of a country refers to the policy framework and legal basis for taxation or production sharing that governs E&P blocks. The fiscal regime governs the negotiation between IOC and HG in the determination of an E&P contract.

Fears of exploitation, pollution, loss of national pride, and tradition stem from the treatment of host countries at the hands of IOCs in the past. Likewise, IOCs harbor a fear of expropriation and privatization of their investment which stem from similar incidents occurring in the past.

Under a Royalty/Tax system, the contract holder secures exploration rights from a private party or government for a specified duration, and development and production rights for each commercial discovery, subject to the payment of royalty and taxes. The IOC bears the full cost and risk of E&P activity, and if no oil is found, the contractor does not receive reimbursement for expenses. The earliest concessionary agreements consisted only of a royalty. As governments gained experience and bargaining power, royalties increased, and various levels of taxation were added. Today, modern concessionary systems employ numerous fiscal devices and sophisticated formulas to capture rent.

Under a PSC, governments usually make contracts under powers granted by general petroleum legislation and frequently negotiate based on a model contract. Ownership of the resource remains with the state, and the IOC is contracted to explore and develop the resource in return for a share of the production. The IOC bears the sole cost and risk of E&P activity, and only if exploration is successful, will be reimbursed for its cost from a share of production. An agreed share of net revenues, referred to as cost oil, is made available to the contractor for recovery of exploration, development and operating costs. The remaining hydrocarbon revenue, called profit oil, is split according to a negotiated formula. The fiscal parameters of a PSC may be subject to bidding or negotiation, and to account for various forms of uncertainty, sliding scales are frequently applied.

12.4. A Brief History of International Arrangements

The earliest international petroleum arrangements were concessions granted at the turn of the century (Blinn et al., 1986). The earliest provisions were highly favorable to the oil company and included

- Very large contract areas,
- Long concession periods,
- No participation by the host country,
- No production requirement, and
- No relinquishment requirement.

The archetypal Middle Eastern concession was obtained by William D'Arcy from the Shah of Persia in 1901. For a $100,000 bonus, $100,000 in stock in his oil company, and a 16% royalty, D'Aray received exclusive oil rights to 500,000 square miles of Persia for the next 60 years. Other concessions in Saudi Arabia, Abu Dhabi, Kuwait, and Oman generally followed the same format (Smith et al., 2000). These concessions did not obligate the companies to drill on any of the lands or to release territory if exploration and drilling was not undertaken. The host country also had no right to participate in managerial decisions and many early concessions freed the companies from all tax obligation. Some later concessions granted in the region were even less favorable, providing a royalty calculated as a flat rate per ton rather than as a percentage of the value of the sale price of production.

In the mid-1950's many Middle Eastern contracts were renegotiated and changes in the concession format evolved into total or partial ownership by the host government on a joint venture basis. Changes in taxation were also introduced. Hybrid fiscal regimes combining royalties with tax structures became more common. OPEC was founded in

1960 and sought to control production and prices by changing the balance of bargaining power in favor of the producing countries and away from the majors. Renegotiation became the vehicle for a substantial restructuring of the traditional concessionary system. NOCs were set up to participate in oil ventures as a vehicle for the government to control and have greater influence of their natural resources. The level of state participation was initially low, but increased with the passage of time.

In 1966, Indonesia negotiated the first production sharing agreement in response to criticism and hostility toward existing concessionary systems. A number of other countries followed Indonesia's lead.

Risk Service (RS) contracts became increasingly popular through the 1980s. In a RS contract, the contractor takes on all of the risk and expense of exploring and developing production, and in return is paid a negotiated fee per barrel produced. In the 1980's, petroleum arrangements tended toward rate of return based profit sharing contracts. Throughout the 1970s and 1980s, governments began experimenting with more direct involvement with production. It has been reported that HGs have tended to take larger shares of gross profits after the formation of OPEC, and especially, after the price rises of 1973 and 1979 (Rutledge and Wright, 1998). In the 1990s, countries focused attention on international competitiveness and fiscal incentives, and as we move into the 21st century, several countries are re-evaluating their fiscal terms in light of sustained high oil prices.

12.5. Fiscal Systems Vary Over Time, Country, Region, and Field

Governments respond to market forces in setting terms and conditions for their acreage and continually "test" the market, in attempting to renegotiate contracts or revise petroleum legislation, and then re-adjusting the terms and negotiation tactics depending on investor reaction. In countries with high prospectivity or unstable political environments, it is a continuous game of give-and-take.

Countries make use of a broad range of tax and nontax instruments to collect revenue from the oil and gas sector, and as one would expect, the strictest fiscal regimes tend to be in countries that offer the most attractive geological prospects, combined with fiscal, legal, political, and macroeconomic stability. Countries that have a strong reserves base and produce more oil than they consume are generally expected to have tighter fiscal policies than importing countries with a moderate reserve base. In some countries, a single fiscal system applies to the entire industry, while in other countries, a variety of fiscal systems may exist. At any point in time, many different contract types are usually in force. Every field in the world is unique in terms of its geologic characteristics and hydrocarbon chemistry, but also in terms of the conditions that lead to a successful E&P contract. Many factors that influence perceptions and negotiation strategies are often unobservable or difficult to quantify.

13.2. Contractual Systems

In a production sharing contract, exploration is performed by the operating company at its own risk and can only be recovered from future production. This feature is not unlike the risk associated with normal exploration, but the difference arises in how expenditures are recovered if reserves are found and the manner in which reserves are split between the

14. LICENSING AND NEGOTIATION

An E&P contract is a legal instrument written between two parties – an oil company and a mineral rights owner – that describe th select values of F and W such that the present value of the work program is less than the expected reward of discovery, $PV(W) < \Sigma\, p_i(W)PV_i(F,W)$.

The HG compares the bids received to determine the most favorable contracts based on the proposed work commitment, (W_i, F_i), $i = 1, \ldots, q$; the technical standing, experience, capabilities, past business practices, and financial position of the IOC; and previous experience and success in exploration in the area or similar areas.

The work program is usually easy to evaluate since it refers to the seismic acquisition, drilling requirements, and/or total expenditures to be made. The present value of the work program is computed and used to compare contractor commitment. Evaluation of the fiscal terms is more complicated, since it is based on conditions that are uncertain (discovery, commerciality, reserve size, field characteristics, etc.) as well as specific assumptions of each bidder. Host governments attempt to balance the tradeoffs involved in selecting a large work commitment and poor fiscal terms versus a small work commitment but more favorable fiscal parameters. In negotiation, the HG and IOC must achieve a balance between maximizing reward and minimizing risk. The HG will need to weight its desire to maximize short-term revenue against any deterre

15. FACTORS THAT IMPACT E&P CONTRACT STRUCTURE

15.1. Categorization

Many factors influence the type of contract a country adopts in E&P activity. Many more factors impact the terms and conditions of the contracts that are actually negotiated. To understand the variations that are possible, it is useful to consider general classification categories and then enumerate factors believed to be relevant (Table A.26). The factor lists are not exhaustive, and usually reflect da

15.2. Factor Description

For a general category, each factor may be proxied by one or more variables, with the selection governed by data availability, user preference, economic theory, or other conditions. Unobservable factors need to be inferred, usually have a higher degree of uncertainty, and are less reliable in application. All proxies are noisy and do not necessarily provide a correlation between a factor and measure.

15.2.1. Reserves Additions: Proved reserves can be augmented through exploration and development of new discoveries, through technological improvements, as well as the existence of more favorable economic conditions. Reserves additions represent the change in proved reserves over a period of time, and are linked in an uncertain manner, to the amount of investment.

15.2.2. R/P Ratio: The reserves-to-production (R/P) ratio is a measure of the potential availability of a resource over time. The R/P ratio describes the proved reserves inventory of an entity (e.g., company, country, region, world) at a specific point in time divided by the production rate at the same time. The R/P ratio is normally interpreted as the number of years that the existent reserves base can sustain the current level of production.

The uncertainty of R/P is small, since both the numerator and denominator term are reasonably well known quantities, but the ratio itself contains less information than it

15.2.5. Industry Structure: IOCs may be classified in terms of their size via reserves base or market capitalization, operational areas, degree of vertical integration, or any of several other measures. NOCs may be classified in terms of their OPEC membership, demand or supply nature, operational areas, or economic strength.

15.2.6. Economic Strength: The economic strength of a country and the experience of the NOC provide an indicator of the relative bargaining position of the country in negotiation with the IOC. Economic strength can be measured in absolute (e.g., GDP) or relative terms (GDP per capita).

15.2.7. Economic Growth: Economic growth in oil producing nations increase the country demand for oil which can be satisfied by local production. Nations whose oil exporting sector is a major component of their GDP are typically led by the expansion of the sector. High oil prices create an inflow of oil demand revenue increasing GDP growth.

15.2.8. Oil Price Risk: If a government obtains substantial revenue from oil production and exports, changes in oil prices will have an impact on revenues generated (Table A.27). Oil price risk is the contribution that changes in oil prices makes to the variance in GDP – the greater the contribution, the greater the premium.

15.2.9. Oil Intensity: Oil intensity is defined as the consumption of oil per $1000 of GDP. Net oil trade as a percent of GDP is another potentially relevant indicator, since as

The relationship between the factors that describe and characterize a fiscal system and the fiscal terms observed in signed contracts follow readily discernable hypothesis, but the veracity of the results need to be continually probed and questioned. Factor relations are tested by asking the question: “How do we expect a fiscal system to be perceived by an investor for a factor with a ‘high’ versus a ‘low’ value while holding ‘all other factors constant’?”

- A region with a high geologic prospectivity, as measured by proved reserves or production rate, will likely have tougher terms than a region with a low geologic prospectivity, for all other factors constant.

- Countries that are net exporters will likely set tougher conditions on the terms and conditions of exploration relative to net importing countries. A region with a high F&D cost will likely offer better terms than a low F&D cost region.

- Frontier acreage is expected to offer better terms because of the additional risk and uncertainty associated with exploration, while for a mature region (as measured, say, by the number of years past peak production), the sign is likely to be ambiguous – the potential for large discoveries is reduced, but this may be balanced by greater regulatory certainty and infrastructure and service networks that will keep development costs down[12].

- If a government obtains substantial revenue from oil production and exports, changes in oil prices will have an impact on revenues generated and may impact fiscal terms, both current and future contracts, but the direction of the impact is difficult to ascertain. It is expected that countries with a high oil price risk premium will have more lenient terms, for other factors constant, and as the proportion of oil revenues increase, the host country may desire to exert greater control.

- The size of a company, its economic strength, international experience, and strategic objectives play an important role in contract negotiations. The role and power of the NOC, local/global experience, participation requirements,

- Royalty/Tax systems are the oldest in the world, and due to political, historical, and other conditions, if a country has been under such a system for a length of time, momentum may maintain the framework with adjustments being made to the terms of the contract. PSCs are likely to be the preferred contract type in new acreage rounds.

16. CONTRACT SELECTION

16.1. Data Source

The type of contracts countries use to govern their E&P industry are observable features obtained either by examining a country's pe

- *Industrialized*. Developed economies are classified as laissez faire (lack of government intervention) and dirigiste (directed economies). In laissez faire economies, there is a strong rule of law with the terms/conditions of E&P generally favorable. In dirigiste economies, the state is viewed as protection against business and state oil companies as proprietor and custodian of the nation's resources. In dirigiste economies, access may be limited to the NOC, and if access is open, the fiscal terms are expected to be more stringent. In both developed and dirigiste economies, Royalty/Tax systems are standard; PSCs and resource rent tax (RRT)-based systems are rare.

- *OPEC*. In "rich" OPEC countries, there is a powerful NOC and the IOC serves as a contractor under Service Contracts with limited access. The E&P terms are tough with little upside potential. In "less rich" OPEC countries, the NOC is less powerful and foreign investment is required. E&P contracts in these countries are more conducive to investment, but the risk premium is also higher.

- *FSU*. Russia and FSU countries have generally been resistant to foreign partners, and in recent years, Russia has made the decision to consolidate/monopolize its energy empire which will further restrict foreign investment. The rule of law is still not firmly established in the region, and corruption levels are similar to many less rich OPEC countries. The presence of significant oil and gas resources means that E&P terms are tough. FSU countries with good prospectivity such as Kazakhstan, Uzbekistan, and Turkmenistan have been more open to foreign investment, at least in their initial license rounds, but their close geographic proximity to Russia and China is likely to lead to more limited access for western investment in the future. FSU countries with modest or low prospectivity such as Tajikistan, Kygisistan, Ukraine, and Belarus have more Tf0.46 0 TD(5ed ir71c0.0aTwrl-i/g)4.9(t)-Srlo.000

Arabia, Kuwait), although Mexico also employs service contracts but is not a strong exporter. Multiple factors can be adopted in a regression modeling framework to help explain contract type and terms, but the weak correspondence, noisy proxies, and the multiple correlating factors imply that analytic models will at best only partially explain the variability that is observed.

17. CONTRACT TERMS, CONDITIONS, COMPARISONS

17.1. Negotiating Contract Terms

The terms and conditions of a contract are negotiated between two parties, at a specific point in time, and for specific acreage. The parties to the negotiation have a unique history; with different experiences, strengths, weaknesses, and objectives; and their own perception of the prospectivity of the region and investment risk. The confluence and interaction of these factors, many of which are unobservable and not conducive to quantitative analysis, will mean that the determination of a primary factor set to assess

17.3. Take Measure

Take is the most common method to compare fiscal systems, and like many other (one-dimensional) metrics, is frequently misapplied and misunderstood (Johnston, 2002). Data on government take for projects and countries are readily available, but their calculation and interpretation is subject to a high degree of uncertainty which is frequently ignored or miss-specified.

There are two methodological approaches to the computation of take. We can apply “standard field conditions” to a given fiscal system and assess the fiscal regime indirectly, or we can attempt to compute the expected value of take ex-ante under “specific field conditions” that are known or expected to hold for the field. Strengths and

17.4.1. Bid Submission:

- Take statistics are provided by various commercial vendors, but use and comparison of the data must be based upon careful assessment and clear knowledge of the assumptions involved.

17.6. Production Sharing Agreement Statistics

Rutledge and Wright claim that a 50:50 split between government and contractor take was considered a fair value before the mid 1970s, and in a study performed by Petroconsultants in 1995 showed that in more than 90% of 110 countries examined, government take ranged from 55%-75%. Mommer and others has shown similar levels of taxation (Mommer, 2002a).

In a 1998 study, Bindemann examined 268 PSAs signed by 74 countries over the period 1966-1998. Each contract was defined with respect to the parties involved in the arrangement (host country, foreign partner(s)), the year the contract was signed, the location (onshore, offshore) of the field, and several other factors.

The royalty rate and cost of oil are reported as the maximum rates while profit oil shares are reported in terms of the minimum and maximum values. Signature and production bonuses are described in U.S. dollars. A summary of the main results are depicted in Table A.34. The results “support” most of assumptions concerning on-shore vs. off-shore regions, import vs. export countries, and regional prospectivity; e.g., royalty rates and signature bonuses for offshore regions and import nations tend to be slightly smaller (more generous) than on-shore regions and export nations, and trends in royalty and maximum cost oil have increased over time.

The results of the study should nonetheless be interpreted with caution, for several reasons:

- The sample set Bindemann employed is not well defined, and its relation to the set of all contracts not described.
- “Model” contracts are frequently used in analysis, but most parameters of model contracts are subject to negotiation or may be biddable, and are not expected to be representative of actual contracts. Significant bias will be introduced into analysis when using model contracts.
- The field characterizations which define the nature of the contracts (“onshore/offshore,” “import/export”) is not described.
- PSA’s employ contracts with sliding roya

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APPENDIX

TABLES AND FIGURES

Table A.1

Various Risks Exist in Oil and Gas Investment

Risk Category	Type
Economic	Market Construction Operation Macroeconomic
Geologic	Reserve Production
Political	Regulatory Transfer-of-profit Expropriation/nationalization
Legal	Contract Jurisdictional
Force majeure	Natural disaster Civil unrest Strikes Terrorism

Table A.2

Examples of Integrated Companies Classified According to Geographic Operation

International	U.S. Integrated	Canadian Integrated	Non-North American
BP	Amerada Hess	Husky Energy	BASF A.G.
Chevron	ConocoPhillips	Imperial Oil	BG Group
Exxon Mobil	Murphy Oil	Petro Canada	BHP Billiton
Royal Dutch Shell	Marathan Oil	Suncor Energy	ENI
Total			Lukoil
			MOL
			Petrobras
			Petrochina
			Petro Kazakhstan
			Petroleos Mexicanos
			Repsol
			Sinopec
			Statoil

Table A.3

Examples of Independent Companies Classified According to Size and Geographic Operation

International	Large U.S.	Mid-Sized U.S.	Small-U.S.	Non-North American
Anadarko Petroleum	Cabot Oil & Gas	Berry Petroleum	Harken Energy	Cairn Energy
Apache	Chesapeake Energy	Comstock Resources	McMoRan Exploration	Chaparral Resources
Burlington Resources	Forest Oil	Denbury Resources	Meridian Resources	CNOC
Devon Energy	Newfield Exploration	Energy Partners	PetroQuest Energy	Global SantaFe
EnCana	Noble Energy	Houston Exploration	Remington Oil & Gas	Nelson Resources
EOG Resources	Pogo Producing	Magnum Hunter Resources	Tetra Technologies	Transmendian Exploration
Kerr-McGee	Vintage Petroleum	Stone Energy	W&T Offshore	Venture Production
Nexen	XTO Energy	Swift Energy		Woodside Petroleum
Occidental Petroleum				
Talisman Energy				
Unocal				

Table A.5

Table A.7

Percentage Yields of Refined Petroleum Products from Crude Oil in the U.S., 1964-2003 (%)

	1964	1974	1984	1994	2003
Gasoline	44.1	45.9	46.7	45.7	46.9
Distillate fuel oil	22.8	21.8	21.5	22.3	23.7
Resid, fuel oil	8.2	8.7	7.1	5.7	4.2
Jet fuel	5.6	6.8	9.1	10.1	9.5
Coke	2.6	2.8	3.5	4.3	5.1
Asphalt	3.4	3.7	3.1	3.1	3.2
Liquefied gases	3.3	2.6	1.9	4.2	4.2
Total (%)	90.1	92.3	92.9	95.4	96.8

Table A.10

World Proven Reserves (2004) and Undiscovered Resources (2000)

Region	Oil – Billion barrels (Bbbl)			
	Proven	Undiscovered Resources		
	Reserves	F95	F5	Mean
USA	22,446	60,500	94,700	75,600
North America	40,268	67,302	252,190	146,091
FSU	79.4	35,601	225,654	115,985
Middle East and North Africa	743.4	73,286	423,178	229,882
Asia Pacific	35.9	8,726	58,653	29,780
South Asia	5,735	1,032	6,957	3,580
Central and South Africa	102.6	20,090	230,727	105,106
Sub-Saharan Africa and Antarc				

Table A.11

World Proved Oil Reserves (2004)

Country	At end 1984 Thousand million barrels	At end 1994 Thousand million barrels	At end 2004 Thousand million barrels	At end 2004 Share of total
USA	36.1	29.6	29.4	2.5%
Canada	9.4	10.4	16.8	1.4%
Mexico	56.4	49.8	14.8	1.2%
Total North America	**101.9**	**89.8**	**61.0**	**5.1%**
Argentina	2.3	2.3	2.7	0.2%
Brazil	2.0	5.4	11.2	0.9%
Colombia	1.1	3.1	1.5	0.1%
Ecuador	1.1	3.5	5.1	0.4%
Peru	0.7	0.8	0.9	0.1%
Trinidad & Tobago	0.6	0.6	1.0	0.1%
Venezuela	28.0	64.9	77.2	6.5%
Other S. & Cent. America	0.5	1.0	1.5	0.1%
Total S. & Cent. America	**36.3**	**81.5**	**101.2**	**8.5%**
Azerbaijan	n/a	n/a	7.0	0.6%
Denmark	0.5	0.8	1.3	0.1%
Italy	0.6	0.7	0.7	0.1%
Kazakhstan	n/a	n/a	39.6	3.3%
Norway	4.9	9.6	9.7	0.8%
Romania	1.5	1.0	0.5	È
Russian Federation	n/a	n/a	72.3	6.1%
Turkmenistan	n/a	n/a	0.5	È
United Kingdom	6.0	4.3	4.5	0.4%
Uzbekistan	n/a	n/a	0.6	È
Other Europe & Eurasia	83.2	63.9	2.5	0.2%
Total Europe & Eurasia	**96.7**	**80.3**	**139.2**	**11.7%**
Iran	58.9	94.3	132.5	11.1%
Iraq	65.0	100.0	115.0	9.7%
Kuwait	92.7	96.5	99.0	8.3%
Oman	3.9	5.1	5.6	0.5%
Qatar	4.5	3.5	15.2	1.3%
Saudi Arabia	171.7	261.4	262.7	22.1%
Syria	1.4	2.7	3.2	0.3%
United Arab Emirates	32.5	98.1	97.8	8.2%
Yemen	0.1	0.1	2.9	0.2%
Other Middle East	0.2	0.1	0.1	È
Total Middle East	**430.8**	**661.7**	**733.9**	**61.7%**
Algeria	9.0	10.0	11.8	1.0%
Angola	2.1	3.0	8.8	0.7%
Chad	-	-	0.9	0.1%
Rep. of Congo	0.8	1.4	1.8	0.2%
Egypt	4.0	3.9	3.6	0.3%
Equatorial Guinea	-	0.3	1.3	0.1%
Gabon	0.6	1.4	2.3	0.2%
Libya	21.4	22.8	39.1	3.3%
Nigeria	16.7	21.0	35.3	3.0%
Sudan	0.3	0.3	6.3	0.5%
Tunisia	1.8	0.3	0.6	0.1%
Other Africa	1.0	0.6	0.5	È
Total Africa	**57.8**	**65.0**	**1120 353.0%**	

Table A.12

World Undiscovered Oil Resources, 2000 (Thousand Million Barrels)

Country	Onshore	Offshore	Total
USA		85.9	
Canada	1.0	1.8	2.8
Mexico	7.7	12.9	20.6
North America			
Argentina	2.0	1.3	3.2
Brazil	*	46.7	46.7
Colombia	5.1	-	5.1
Ecuador	0.8	0.2	1.0
Peru	1.8	1.5	3.3
Trinidad & Tobago	*	0.7	0.8
Venezuela	15.6	4.1	19.7
South & Central America			105.1
Denmark	-	0.1	0.1

Table A.13

World Proved Natural Gas Reserves (2004)

Country	At end 1984 Trillion cubic meters	At end 1994 Trillion cubic meters	At end 2004 Trillion cubic meters	At end 2001 Share of total
USA	5.53	4.59	5.29	2.9%
Canada	2.81	1.90	1.60	0.9%
Mexico	2.17	1.94	0.42	0.2%
Total North America	**10.51**	**8.42**	**7.32**	**4.1%**
Argentina	0.67	0.54	0.61	0.3%
Bolivia	0.13	0.11	0.89	0.5%
Brazil	0.08	0.15	0.33	0.2%
Colombia	0.11	0.21	0.11	0.1%
Peru	+	0.34	0.25	0.1%
Trinidad & Tobago	0.31	0.29	0.53	0.3%
Venezuela	1.67	3.97	4.22	2.4%
Other S. & Cent. America	0.24	0.23	0.17	0.1%
Total S. & Cent. America	**3.23**	**5.83**	**7.10**	**4.0%**
Azerbaijan	n/a	n/a	1.37	0.8%
Denmark	0.10	0.12	0.09	È
Germany	0.31	0.22	0.20	0.1%
Italy	0.25	0.30	0.17	0.1%
Kazakhstan	n/a	n/a	3.00	1.7%
Netherlands	1.90	1.85	1.49	0.8%
Norway	0.56	1.73	2.39	1.3%
Poland	0.09	0.16	0.12	0.1%
Romania	0.21	0.43	0.30	0.2%
Russian Federation	n/a	n/a	48.00	26.7%
Turkmenistan	n/a	n/a	2.90	1.6%
Ukraine	n/a	n/a	1.11	0.6%

Table A.14

World Undiscovered Natural Gas Resources, 2000 (Trillion cubic feet)

Country	Onshore	Offshore	Total
USA		419.9	
Canada	15.6	8.9	24.5
Mexico	20.5	28.7	49.3
Total North America			
Argentina	21.8	14.9	36.7
Brazil	0.2	194.2	192.4
Colombia	10.1	-	10.1
Ecuador	0.3	0.2	0.6
Peru	1.9	4.4	6.3
Trinidad & Tobago	1.1	30.7	31.8
Venezuela	60.3	41.0	101.2
Total S. & Cent. America			487.2
Denmark	-	0.8	0.8
Italy	13.0	14.3	27.3
Norway	-	183.0	183.0
Romania	5.4	-	5.4
United Kingdom	*	23.3	23.4
Total Europe			312.4
Azerbaijan	1.6	65.9	67.4
Kazakhstan	38.6	33.7	72.3
Russian Federation	398.0	770.8	1,168.7
Turkmenistan	142.4	65.3	207.7
Uzbekistan	12.8	2.3	15.0
Total Former Soviet Union			1,611.3
Iran	176.2	138.4	314.6
Iraq	120.0	-	120.0
Kuwait	2.8	3.1	5.9
Oman	32.4	1.3	33.7
Qatar	17.5	23.6	41.1
Saudi Arabia	625.1	55.9	681.0
Syria	5.1	-	5.1
United Arab Emirates	28.5	16.0	44.5
Yemen	21.4	0.5	21.9
Total Middle East			1,370.0
Algeria	46.5	2.5	49.0
Angola	1.4	41.3	42.7
Cameroon	1.8	3.8	5.6
Republic of Congo	0.5	16.9	17.4
Egypt			
Gabon	2.8	21.5	24.3
Libya	12.8	8.3	21.1
Nigeria	55.1	68.1	123.2
Tunisia	4.9	2.3	7.1
Total Africa			235.3
Australia	3.4	106.0	109.4
Brunei	0.4	12.0	12.4
China	82.1	3.6	85.8
India	13.1	17.2	30.3
Indonesia	43.4	64.3	107.7
Malaysia	0.4	49.7	50.2
Papua New Guinea			
Thailand	-	4.7	4.7
Vietnam	-	0.8	0.8
Total Asia Pacific			498.9
TOTAL WORLD			5,196.4

Source: (USGS, 2000). Note: ‡Excludes Former Soviet Union, *Less than 0.05%, n/a: Not available.

Table A.15

Bitumen (Tar Sands) and Heavy Oil Technically Recoverable Resources (2003)

Region	Bitumen (Bbbl)	Heavy Oil (Bbbl)
Western Hemisphere	531.0	310.0
North America	530.9	35.3
South America	0.1	265.7
Eastern Hemisphere	119.7	133.3
Africa	43.0	7.2
Europe	0.2	4.9
Middle East	0	78.2
Asia	42.8	29.6
Russia	33.7	13.4
World Total	650.7	434.3

Source: (USGS, 2000).

Table A.16

Oil Production and Consumption Among Primary Producing Countries (2004)

Country	Production (1,000 barrels daily)	Consumption (1,000 barrels daily)	Production-Consumption (1,000 barrels daily)
USA	7241	20517	-13276
Canada	3085	2206	879
Mexico	3824	1896	1928
Total North America	**14150**	**24619**	**-10469**
Argentina	756	393	363
Brazil	1542	1830	-288
Colombia	551	223	328
Ecuador	535	140	395
Peru	93	153	-60
Trinidad & Tobago	155		155
Venezuela	2980	577	2403
Other S. & Cent. America	152	1424	-1272
Total S. & Cent. America	**6764**	**4739**	**2025**
Azerbaijan	318	91	227
Denmark	394	189	205
Italy	104	1871	-1767
Kazakhstan	1295	192	1103
Norway	3188	209	2979
Romania	119	212	-93

Table A.17

OPEC Production Quotas (Million Barrels per Day)

Country (OPEC Membership)	2000	2001	7/2005 (Quota)	2/2006 (Production)
Saudi Arabia (1960)	8.26	7.58	9.10	9.40
Iran (1960)	3.68	3.43	4.11	3.90
Venezuela (1960)	3.03	2.57	3.22	2.50
Iraq (1960)	2.57*	2.03*	-	1.80
UAE (1967)	2.23	2.00	2.44	2.50
Nigeria (1971)	2.03	1.97	2.31	2.20
Kuwait (1960)	2.10	1.87	2.25	2.60
Libya (1962)	1.41	1.30	1.50	1.65
Indonesia (1962)	1.27	1.10	1.45	0.92
Algeria (1969)	0.81	0.88	0.89	1.38
Qatar (1961)	0.67	0.66	0.73	0.80
OPEC Total	28.06	25.39	28.00	27.85

Table A.19

Sources and Uses of Cash for FRS Companies, 2003-2004 (Current Billion Dollars)

Sources and Uses of Cash	2003	2004	Percent Change
Main Sources of Cash			
Cash Flow from Operations	105.1	135.8	29.2
Proceeds from Long-Term Debt	26.4	18.5	-29.7
Proceeds from Disposals of Assets	16.1	19.7	22.2
Proceeds from Equity Security Offerings	8.4	8.1	-3.2
Main Uses of Cash			
Additions to Investment in Place	80.0	86.5	8.2
Reductions in Long-Term Debt	26.2	18.4	-29.8
Dividends to Shareholders	42.8	36.5	-14.6
Purchase of Treasury Stock	6.1	14.0	131.2
Other Investment and Financing Activities, Net	7.9	-5.5	-169.5
Net Change in Cash and Cash Equivalents	8.8	21.2	140.7

Source: (EIA, 2004).

Table A.20

Exploration and Development Expenditures by Region for FRS Companies, 1998-2004 (Current Million Dollars)

Total E&P Expenditures	1998	1999	2000	2001	2002	2003	2004
U.S. Onshore	13,460	6,570	27,089	24,244	22,330	14,743	21,860
U.S. Offshroe	10,968	6,917	20,955	9,614	9,482	12,453	10,530
Total United States	24,428	13,487	48,044	33,858	31,812	27,196	32,390
Canada	4,806	2,056	4,881	15,324	6,687	4,903	5,318
OECD Europe	8,586	4,137	7,520	5,373	9,794	5,730	4,408
Former Soviet Union and E. Europe	1,267	606	893	881	1,273	2,120	2,042
Africa	3,134	3,094	2,719	5,547	6,091	9,187	6,901
Middle East	942	393	550	739	774	976	1,271
Other Eastern Hemisphere	3,949	3,442	6,787	4,991	6,195	4,161	3,761
Other Western Hemisphere	3,709	3,790	5,448	3,090	1,558	1,131	1,635

Table A.21

Representative Global Upstream Oil and Gas Investment Comparison

Year	O&GJ[a]	Arthur Anderson	Lehman[b]	Chase/Salomon[c]
1995	55.9	54.5	84	69
1996	63.0	48.9	97	88
1997	75.0	89.6	115	67
1998	74.2	89.0	114	82
1999	78.4	95.7	90	92
2000	85.4	124.1	108	115
2001	106.9		127	110
2002			117	121

Table A.22

U.S. Capital Spending, 1994-2003 (Current Million Dollars)

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Drilling-Exploration	12,036	12,842	17,098	22,725	22,835	18,312	24,340	39,927	31,942	34,500
Production	2,365	2,519	3,354	4,458	4.349	3,479	4,625	7,586	6.070	6,556
OCS Lease Bonus	331	414	878	1,411	1,320	249	442	1,004	504	476
Subtotal	**14,732**	**15,775**	**21,330**	**28,594**	**28,504**	**22,040**	**29,407**	**48,517**	**38,516**	**41,532**
Refining	5,082	4,903	3,932	3,102	3,486	3,525	4,142	3,930	4,952	6,000
Petrochemicals	2,245	3,347	3,341	2,763	2,871	2,007	870	917	963	915
Marketing	2,473	2,545	2,913	2,960	3,024	2,613	2,867	3,300	2,310	2,310
Crude & Products Pipelines	778	768	632	851	1,228	1,058	201	570	260	260
Natural Gas Pipelines	1,352	1,527	1,120	1,704	1,928	1,824	3,261	3,008	4,850	4,850
Other Transportation	730	602	657	722	750	681	682	706	568	568
Mining & Other Energy	714	758	665	884	902	601	556	550	660	660
Miscellaneous	2,223	2,256	2,310	2,545	2,564	2,196	2,241	3,900	3,800	3,800
Subtotal	**15,597**	**16,706**	**15,570**	**15,531**	**16,753**	**14,505**	**14,820**	**16,881**	**19.363**	**19,363**
Total	**30,329**	**32,481**	**36,900**	**44,125**	**45,257**	**36,545**	**44,227**	**65,398**	**55,476**	**60,895**

Source: (Beck, 2004).

Table A.23

Worldwide Petroleum Industry Capital Spending, 1990-2001 (Current Million Dollars)

Regions and Sectors	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
US and Canada												
Crude Oil & Natural Gas	22,048	23,424	17,003	21,504	23,940	24,616	30,140	36,674	39,075	41,890	47,538	62,205
Refineries	4,930	6,831	6,933	6,031	5,678	5,472	4,382	3,411	3,834	4,163	4,762	4,355
Subtotal	**26,978**	**30,355**	**23,936**	**27,535**	**29,618**	**30,088**	**34,522**	**40,085**	**42,909**	**46,053**	**52,300**	**66,560**
Mexico, C. and S. America												
Crude Oil & Natural Gas	6,220	7,605	6,254	5,637	7,362	9,130	9,290	10,938	9,573	10,043	10,513	12,377
Refineries	1,864	1,848	1,872	1,938	1,955	2,057	2,080	2,130	2,106	2,358	2,609	2,946
Subtotal	**8,084**	**9,453**	**8,126**	**7,575**	**9,317**	**11,187**	**11,370**	**13,068**	**11,679**	**12,401**	**13,122**	**15,323**
Western Europe												
Crude Oil & Natural Gas	14,770	16,829	12,276	11,361	12,290	13,667	14,850	16,220	14,380	14,788	15,196	17,811
Refineries	3,050	3,083	3,061	3,110	3,119	3,186	3,252	3,297	3,320	3,600	3,880	4,273
Subtotal	**17,820**	**19,912**	**15,337**	**14,471**	**15,409**	**16,853**	**18,102**	**19,517**	**17,700**	**18,388**	**19,076**	**22,084**
Middle East and Africa												
Crude Oil & Natural Gas	3,957	4,002	4,017	4,403	4,191	4,570	4,876	6,588	6,683	7,078	7,472	8,942
Refineries	1,340	1,277	1,311	1,372	1,432	1,519	1,571	1,610	1,637	1,809	1,980	2,214
Subtotal	**5,297**	**5,229**	**5,328**	**5,775**	**5,623**	**6,089**	**6,447**	**7,198**	**8,320**	**8,887**	**9,452**	**11,156**
Far East and Australasia												
Crude Oil & Natural Gas	4,436	4,695	3,922	4,194	4,156	3,893	3,799	4,605	4,459	4,580	4,701	5,555
Refineries	2,498	2,611	2,759	2,936	3,052	3,385	3,642	3,735	3,781	4,174	4,567	5,104
Subtotal	**6,934**	**7,306**	**6,681**	**7,130**	**7,208**	**7,278**	**7,441**	**8,340**	**8,240**	**8,754**	**9,268**	**10,659**
World Totals												

Table A.24

Lifting Costs by Region for FRS Companies, 2003-2004
(2004 Dollars Per Barrel of Oil Equivalent)

	Direct Lifting Costs		Production Taxes		Total	
Region	2003	2004	2003	2004	2003	2004
United States						
Onshore	--	--	--	--	5.66	6.08
Offshore	--	--	--	--	3.34	4.25
Total United States	3.77	4.19	1.13	1.32	4.90	5.52
Foreign						
Canada	5.34	5.15	0.23	0.23	5.56	5.38

Table A.26

The Prospectivity of a Region Is Influenced by Many Factors

Categorization	Potential Factors

Table A.27

Hydrocarbon Net Exporting Countries Oil and Natural Gas Exports and Fiscal Revenues in 2003

Country	Oil and Gas Exports as a percent of world oil and gas exports	Oil and Gas Exports as a percent of country's GDP	Country's fiscal oil and gas as share of country's GDP
Saudi Arabia	13.5	38.3	28.1
Russian Federation	11.8	17.0	6.0
Norway	6.5	18.4	12.2
United Arab Emirates	4.7	36.8	35.8
Iran	4.3	19.8	16.3
Nigeria	4.3	46.1	28.0
Algeria	3.9	36.2	26.4
United Kingdom	3.8	1.3	0.4
Netherlands	3.4	4.0	n/a
Venezuela	3.3	24.6	23.0
Kuwait	3.0	44.8	48.1
Mexico	3.0	3.0	7.9
Indonesia	2.4	6.3	4.5
Canada	2.4	1.7	0.2
Libya	1.9	47.6	40.5
Iraq	1.6	38.4	n/a
Qatar	1.5	47.0	24.9
Oman	1.5	43.1	35.4
Angola	1.4	65.3	28.3
Malaysia	1.2	7.4	4.3
Kazakhstan	1.1	23.6	6.2
Argentina	0.9	4.3	1.7
Bahrain	0.8	53.9	24.4
Syria	0.7	19.3	14.4
Brunei Darussalam	0.6	80.0	29.1
Denmark	0.6	1.8	0.7
Vietnam	0.6	9.8	5.3
Trinidad & Tobago	0.6	34.4	11.5
Yemen	0.5	30.5	23.6
Colombia	0.5	4.4	2.9
Egypt	0.5	3.9	0.8
Turkmenistan	0.5	26.6	9.3
Equatorial Guinea	0.5	96.6	23.7
Ecuador	0.4	9.7	13.2
Azerbaijan	0.4	31.5	15.2
Congo	0.3	59.1	20.4
Sudan	0.3	12.3	9.5
Gabon	0.2	42.6	16.2
Cameroon	0.2	7.6	4.5
Cote d'Ivoire	0.1	4.9	1.3
Bolivia	0.1	6.1	4.6
Papua New Guinea	0.1	13.0	4.6
Uzbekistan	0.1	3.8	5.2
Chad	0.1	8.3	0.5
Total: 44 Countries	**90.1**		

Source: (IMF, 2004).

Table A.28

One Factor, Two Dimensional Contract Classification

Development Status	Contract Type
Industrial	JV
Developing	JV, PSC

Note: JV=Joint Venture, PSC=Production Sharing Contract.

Table A.29

One Factor, Five Dimensional Contract Classification

Political System	Example Country
Mature Democracy	US, UK, Canada, Norway
Factional Democracy	Ecuador, Venezuela, Columbia
Paternalistic Democracy	Saudi Arabia, Kuwait, Gulf States
Predatory Democracy	Nigeria
Reformist Democracy	Indonesia

Table A.30

Multi-Dimensional Contract Classification

Country/Region	Subcategory	Example Country
Industrialized	Laissez Faire	US, UK, Spain, Canada, Australia, Sweden, Denmark, Finland, Switzerland, Argentine, Chile
	Dirigiste	France, Germany, Norway, Japan, Italy, Austria, Portugal, Greece
OPEC	Rich	Saudi Arabia, Kuwait, UAE, Libya, Qatar, Oman, Iran, Iraq
	Less Rich	Algeria, Venezuela, Indonesia, Nigeria
FSU	High Prospectivity	Russia, Kazakhstan, Uzebekistan, Turkmenistan
	Modest Prospectivity	Azerbaijan, Tajikistan, Kyrgistan
	Low Prospectivity	Ukraine, Belarus
SouthEast Asia	High Prospectivity	Malaysia
	Modest Prospectivity	Thailand, China
	Low Prospectivity	Korea, Taiwan
Africa	High Prospectivity	Angola, Egypt, Libya, Nigeria
	Modest Prospectivity	Chad, Sudan, Niger
	Low Prospectivity	Gabon, Senegal, Morocco

Table A.31

Two Factor, Four Dimensional Contract Classification

Economic Strength	Importer	Exporter
Weak	PSC	JV
	RC	PSC
Strong	JV	PSC
	PSC	SC

Note: JV = Joint Venture, PSC = Production Sharing Contract, RC = Risk Contract, SC = Service Contract.

Table A.32

Representative Contract Terms and Government Take

Country	Contract Type[a]	Government Take[b]	Star System[c]
USA	R/T	Deepwater: (38, 42)	Deepwater: 4
		Shelf : (48,51)	Shelf: 3
Mexico	SC	(30, 32)	
North America			
Argentina	R/T	(47, 49)	5
Colombia	R/T	(79, 82)	1
Ecuador	PSA	(58, 60)	3
Peru	PSA, R/T	(58, 62)	5
Trinidad & Tobago	PSA	Offshore: (48, 50)	Offshore: 4
		Onshore: (62,66)	Onshore: 3
Venezuela	SC	(88, 93)	1
South & Central America			
Italy			5
Norway			2
United Kingdom			5
Europe			
Kazakhstan	PSA, ROR	(83, 88)	
Russian Federation			1
Former Soviet Union			
Syria	PSA	(83, 87)	1
Yemen	PSA	(72, 79)	2
Middle East			
Angola	PSA	(81, 88)	
Republic of Congo	R/T	(67, 69)	
Egypt	PSA	(79, 82)	Offshore: 3
		(85, 90)	Onshore: 1
Gabon	PSA	(69, 76)	1
Nigeria			1
Tunisia	PSA, R/T	(79, 85)	
Africa			
Australia	R/T	Off: (53, 56)	Offshore: 4
		On: (63, 66)	Onshore: 3
Brunei	R/T	(82, 84)	2
China	PSA	(72, 77)	3
India	PSA	(61, 69)	
Indonesia	PSA	East: (69, 71)	1
		West: (87, 89)	1
Malaysia	PSA	Frontier: (69, 74)	Frontier: 3
		Onshore: (88, 91)	Onshore: 2
Papua New Guinea	R/T, ROR	(67, 76)	2
Thailand	R/T	(69, 74)	2
Vietnam	PSA	(79, 82)	
Asia Pacific			

Footnote: (a) PSA = Production Sharing Agreement, R/T = Royalty Tax, ROR = Rate of Return Features, SC = Service Contract.

Table A.33

The Notion of Take Changes Throughout the Life of a Prospect

Stage	Notation	Characteristics
Bid Submission	τ_1	Based on estimates of the field size distribution, expected development cost, production schedule, fiscal terms F, and work commitment W, take is evaluated
Bid Acceptance and Award	τ_2	F and W are negotiated with HG to determine values of τ_2
Commercial Discovery	τ_3	Field size is known and with estimates of development and production costs, F will determine τ_3 subject to exogenous conditions
Production	τ_4	Field size, development costs, production expenses, etc. are known with a higher degree of certainty, and as production proceeds, these parameters become better defined. Take will vary throughout the productive life of a field based on the terms of F and exogenous conditions
Abandonment	τ_5	At abandonment and with perfect information, a “look-back” analysis can be performed to determine the exact value of take as long as cost and revenues are known precisely and the

Table A.34

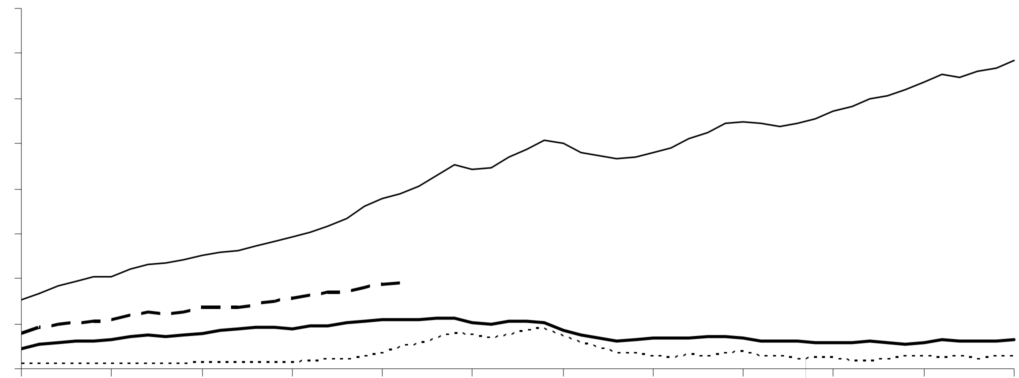
Trends in PSA Contract Terms

	Maximum Royalty (%)	Maximum Cost Oil (%)	IOC Profit Oil		Bonus	
			Max (%)	Min (%)	Signature ($M)	Production ($M)
Onshore	9+	70+++	53+	30	4	5 - -
Offshore	7+++	68+	61++	33++	1.3 -	6
Exporters	10+++	69++	50++	27+	4.5+	8
Importers	5	69++	60+	38+	1.8+	4.6 - -
OPEC	5++	100+++	55++	30+	1.1 - -	10+
South/Central Africa	8+	70+++	62+	32+	2.5	5 -
Eastern Europe	6+++	62+++	58+	38 -	0.8+++	2++
Asia/Australia	5.5++	76+	55++	28	1.8 -	5 - -
Central America/Caribbean	10+	100+++	90+++	50+++	n/a	n/a
Middle East	8.5+	40 -	25 - -	16	6+++	8
North Africa	10+++	85+++	72+++	27++	3+++	6+++
South America	8.5+	60+++	45 -	30 - -	n/a	10+

Source: (Bindemann, 1999).

Footnote: (1) Figures represent 1997/1998 contract averages.

(2) + (-) slight increase (decrease); ++ (- -) increase (decrease); +++ (- - -) strong increase (decrease).



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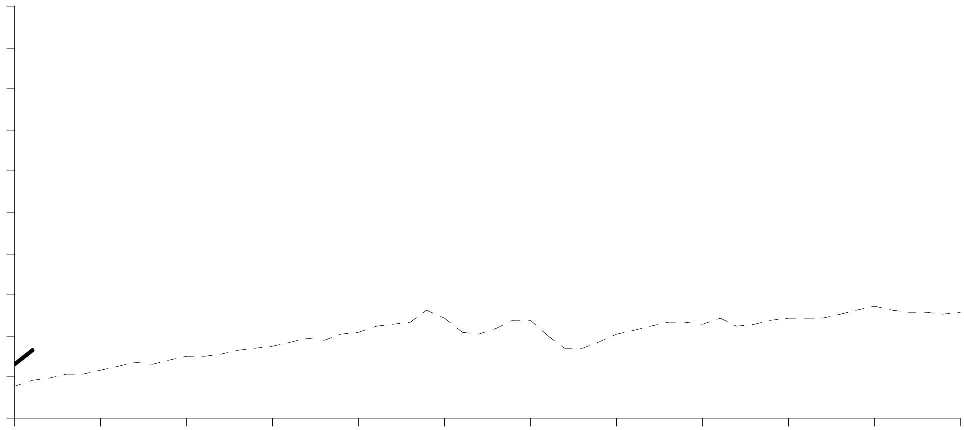

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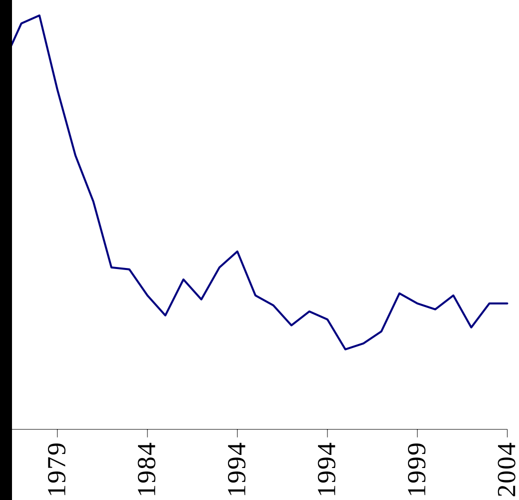

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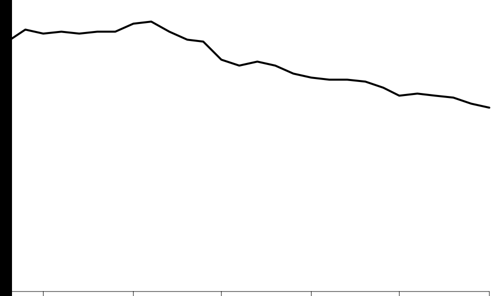

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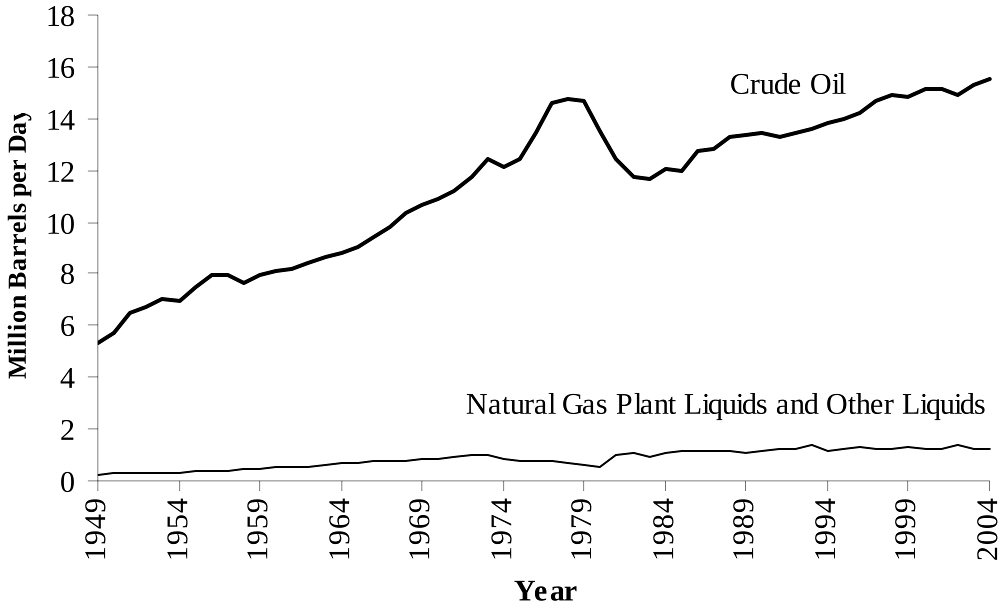
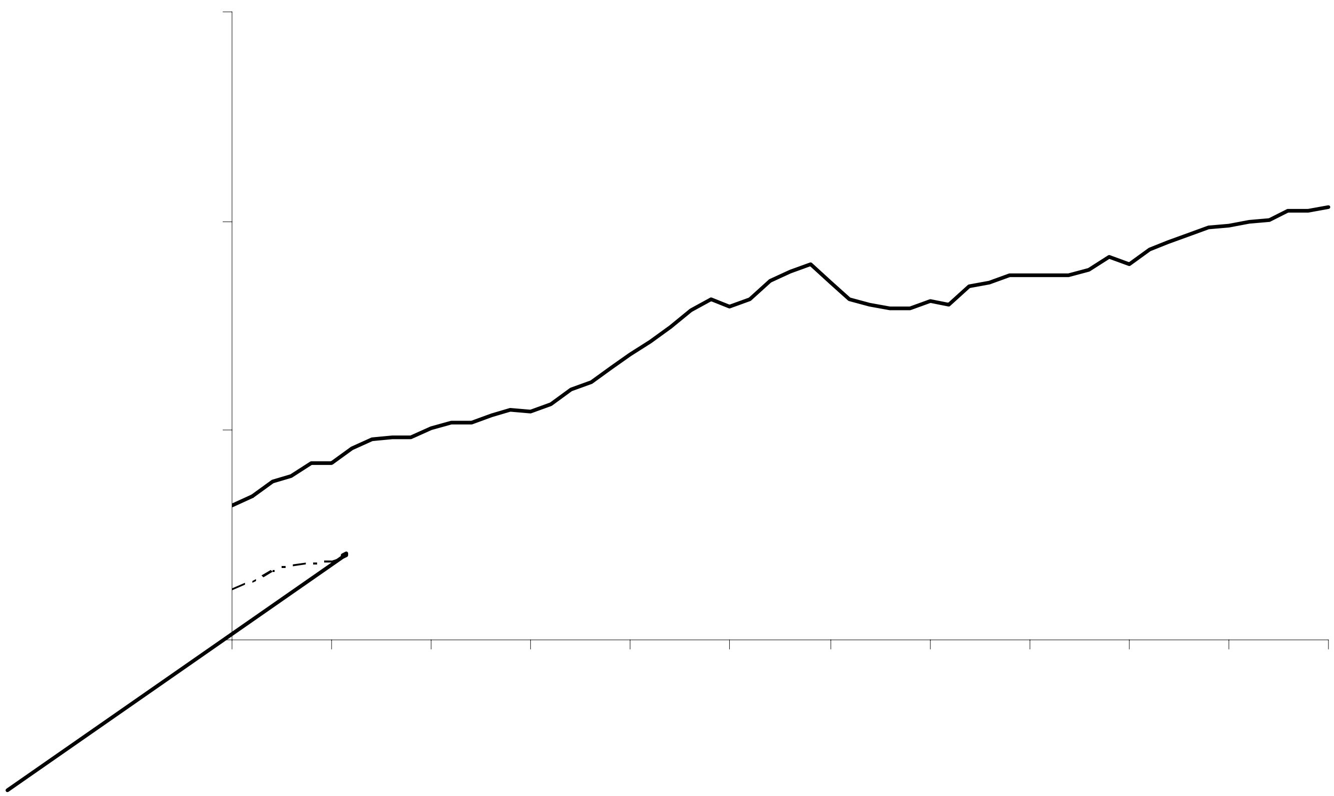
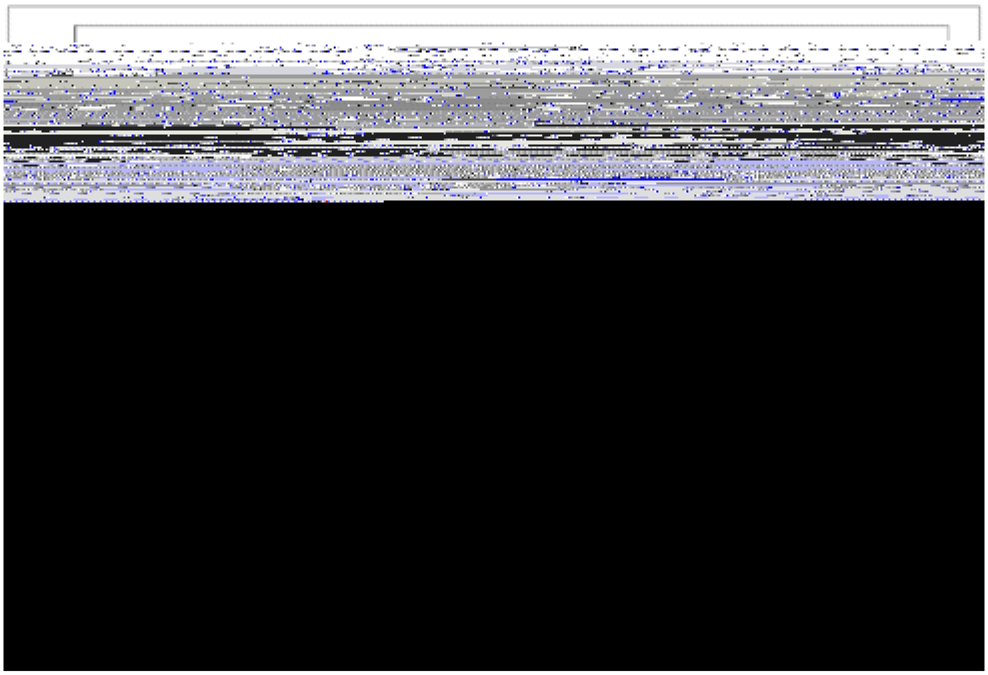


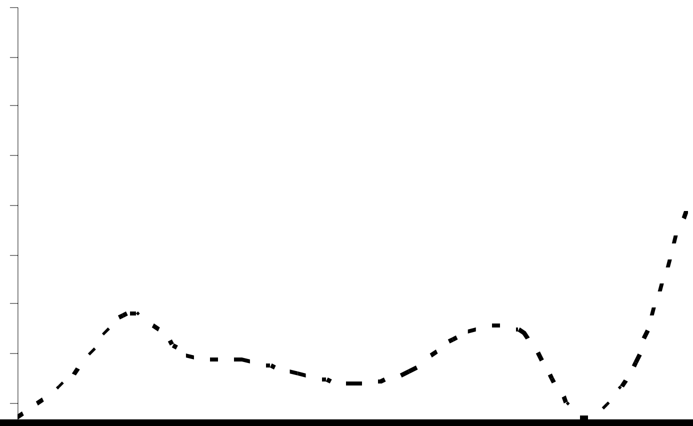
Figure A.7. Refinery Input, 1949-2004 (EIA, 2005).





Selected Events:

1 – OPEC begins to assert power, raises tax rate and posted prices



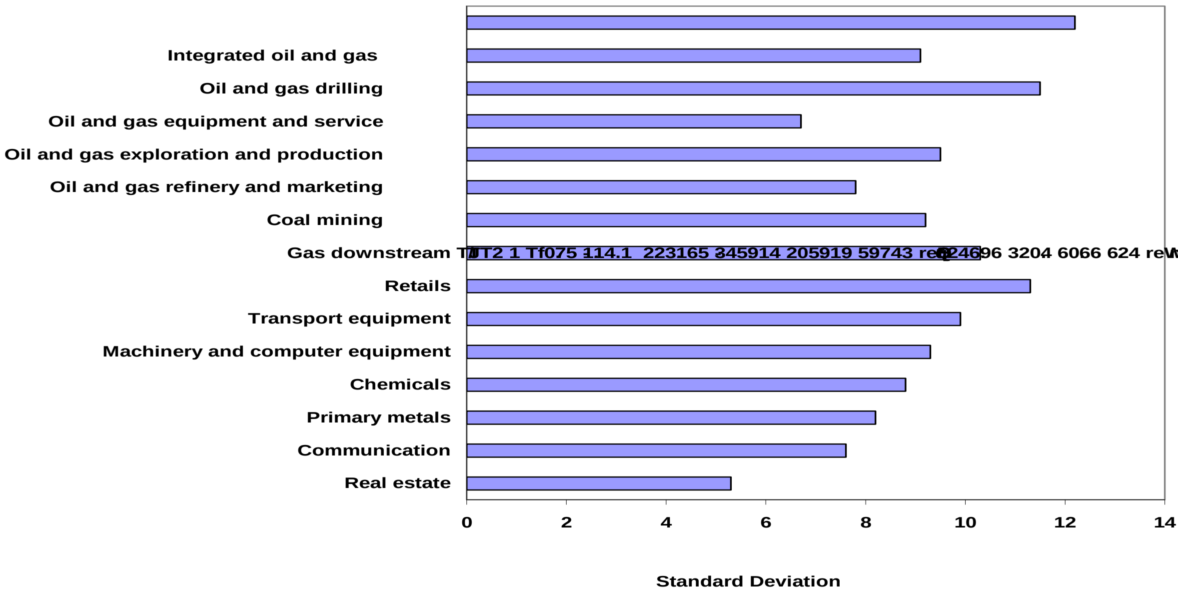


Figure A.12. Volatility of Return on Investment by Industry, 1993-2002 (IEA, 2003).

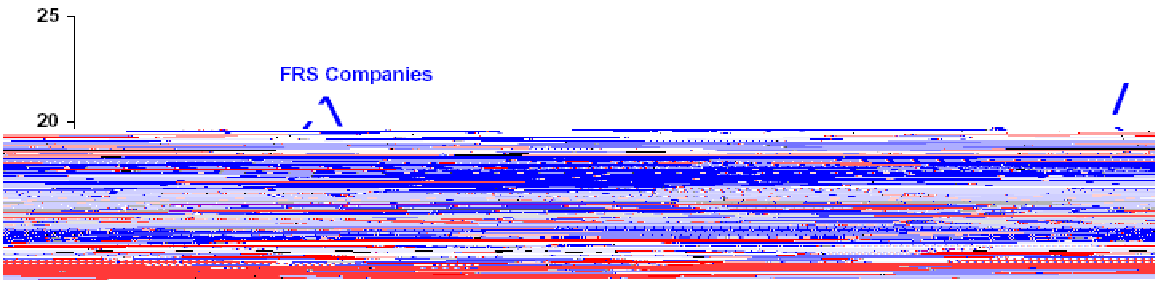


Figure A.13. Return on Stockholder's Equity for FRS Companies and the S&P Industrials, 1973-2004 (EIA, 2004).

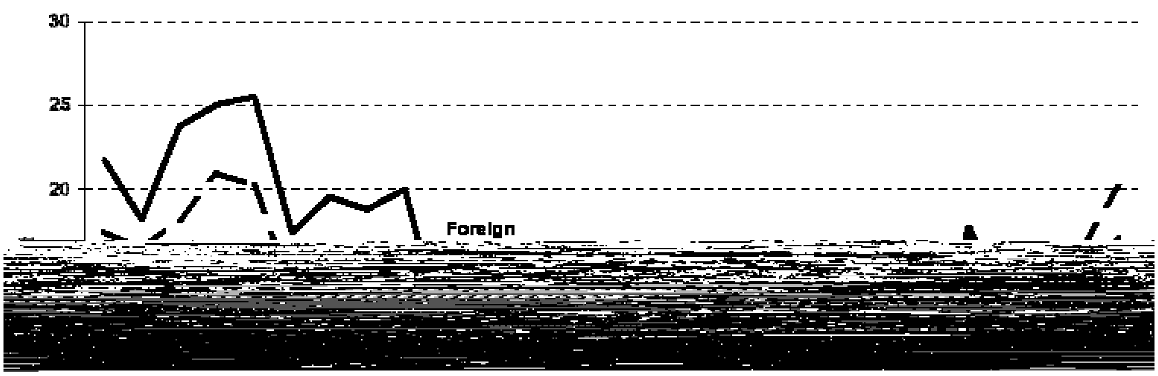


Figure A.14. Return on Net Investment for U.S. and Foreign Oil and Gas Production, 1977-2004 (EIA, 2004).

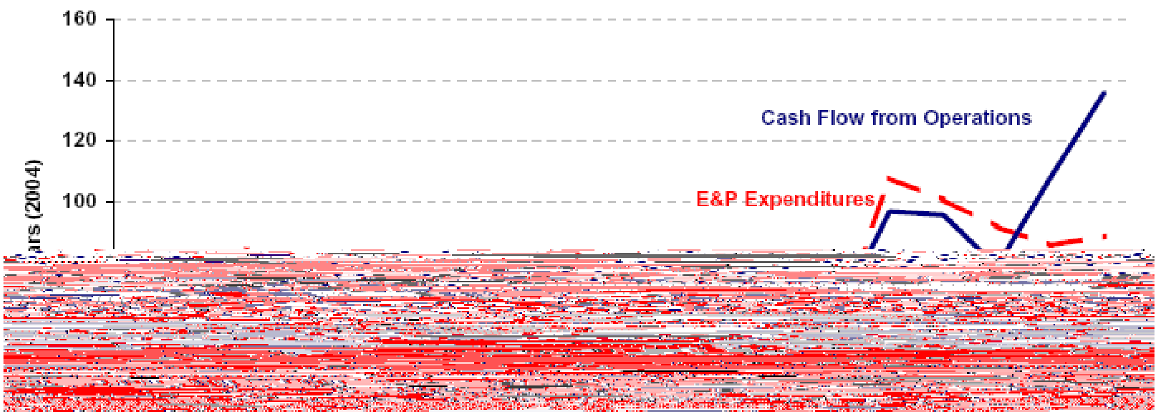


Figure A.15. Cash Flow from Operations and Exploration and Production Expenditures for FRS Companies (EIA, 2004).

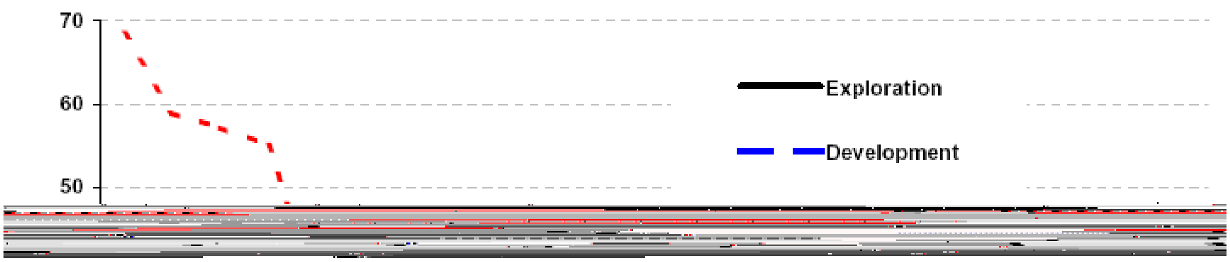


Figure A.16. Worldwide Expenditures for Exploration, Development, and Production for FRS Companies (EIA, 2004).

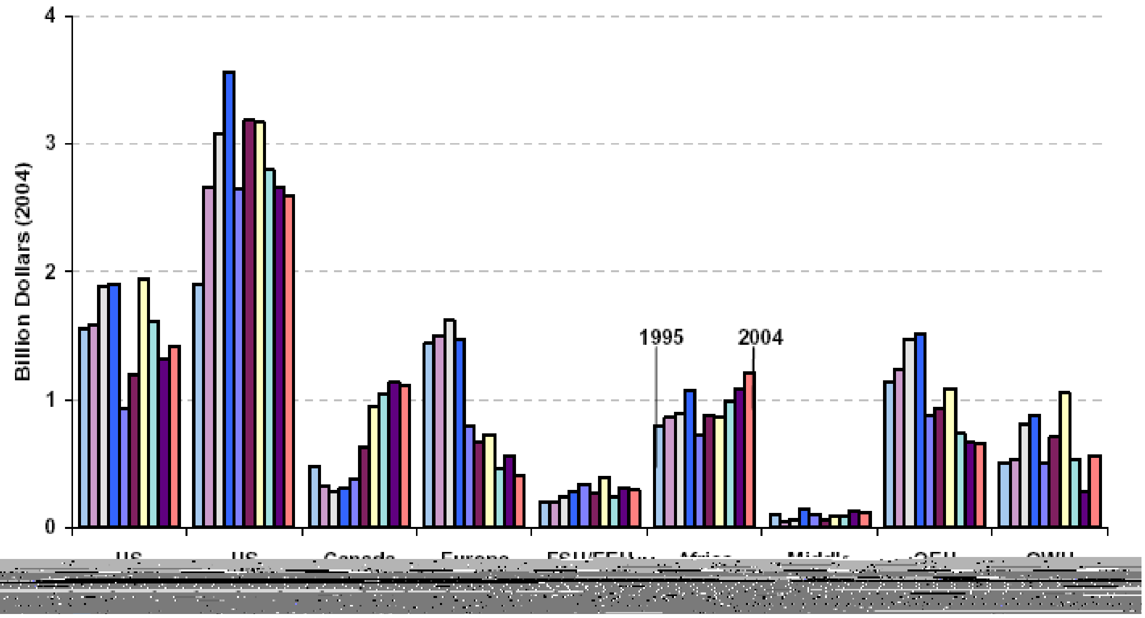
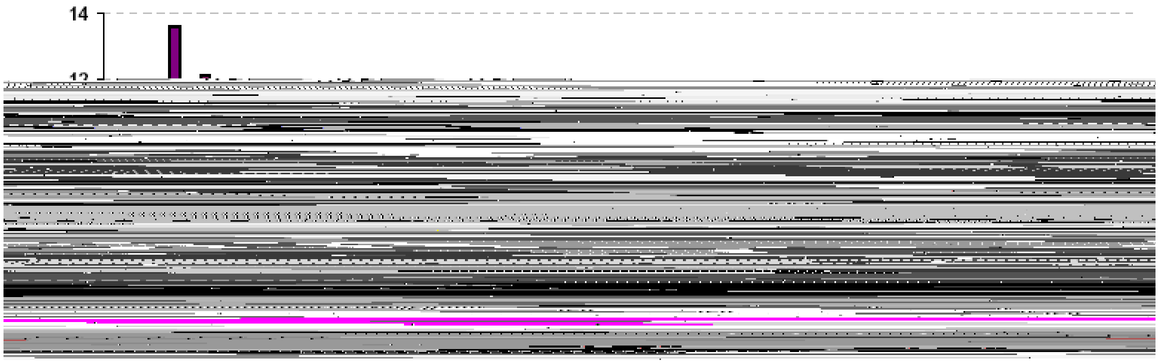


Figure A.17. FRS Expenditures for Oil and Natural Gas Exploration by Region, 1995-2004 (EIA, 2004).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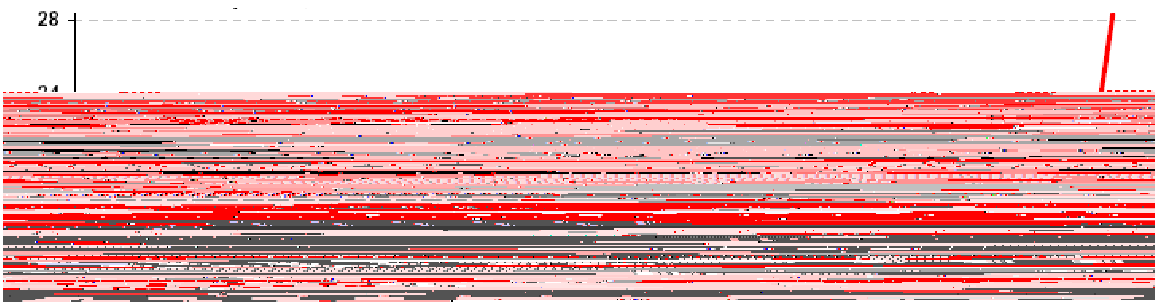

Figure A.20. U.S. Onshore, U.S. Offshore, and Foreign Three-Year Weighted-Average Finding Costs for FRS Companies, 1981-1983 to 2002-2004 (EIA, 2004).

The Department of the Interior Mission

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

The Minerals Management Service Mission