HoustonBusiness

A Perspective on the Houston Economy

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Texas Drilling Directed Toward Unconventional Natural Gas

High oil and natural gas prices have brought Texas the highest levels of drilling activity since the winter of 1985–86. But what has set Texas apart from many other states in 2005 is drilling for unconventional natural gas.

Texas is a declining region for oil and gas production—a high-cost producer that sees rigs blossom across the state as energy prices rise and then disappear as prices fall. The current cycle, still on the upswing, is no exception. High oil and natural gas prices have brought Texas the highest levels of drilling activity since the winter of 1985–86.

Texas has also been a winner in the current drilling cycle relative to other states. The number of working rigs in the United States did not return to its prior peak level, in 2001, until March of this year, according to Baker Hughes; in recent months drilling has been about 5 percent higher than the previous peak. Meanwhile, Texas oilfield activity returned to the 2001 peak last fall and has been operating at 15 to 20 percent above the last peak.

The oil fields have been busy with the usual infield drilling, extensions of existing fields, and the search for new fields in anticlines, faults and other structural traps. But what has set Texas apart from many other states in 2005 is drilling for unconventional natural gas. The search for oil is no longer limited to structural geology; today's fields are uniformly spread over vast areas of coal, shale or impermeable sandstone and limestone. Reserves are shallow, dry holes are rare, and wells are productive and long-lived. Drilling for these unconventional gas reserves currently drives the Texas rig count.

Texas Oil and Natural Gas

The United States ranks 11th in the world in terms of proved oil reserves, just behind Libya and Nigeria and just ahead of China. It ranks sixth in the world in natural gas reserves, just behind Saudi Arabia and the United Arab Emirates. Texas is an important part of these numbers, holding 23 percent of U.S. oil reserves and 25 percent of the nation's natural gas reserves (*Table 1*). Texas is second only to the federal offshore region in oil reserves and ranks second to none in proved gas reserves.

Table 1

Oil and Gas Production by State and Region, 2003

Oil	Millions of barrels	Natural gas	Billion cubic feet
Federal offshore	5,120	Texas	48,717
Texas	4,583	Federal offshore	23,033
Alaska	4,446	Wyoming	22,716
California	3,542	New Mexico	18,226
New Mexico	677	Colorado	15,839
United States	21,891	United States	197,145

SOURCE: Energy Information Administration, *U.S. Crude Oil, Natural Gas, and Natural Gas Liquids Reserves 2003 Annual Report,* November 2004.

Although Texas is still an important piece of the national energy picture, it is in decline. Oil production in Texas peaked in 1972 at 1.3 billion barrels per year; it has since declined 73 percent to 351 million barrels in 2004. Natural gas production peaked the same year but has declined only 39 percent, from 9.6 trillion cubic feet (Tcf) in 1972 to 5.9 Tcf last year.

U.S. natural gas production peaked at 24.1 Tcf in 1971 and fell as low as 19.1 Tcf in 1986, but it has since recovered to 24 Tcf in 2004. However, keeping natural gas production up has not been easy. From 1987 to 1997, there was an average of 400 rigs looking for natural gas in the United States. This jumped to an average of 770 gas-directed rigs after 1997, and in recent months about 1,200 rigs—nearly 90 percent of all U.S. working rigs—have been searching for natural gas (*Figure 1*).

Natural gas has become more important in Texas as well. Figure 2 shows that even at the peak of production in the 1970s, based on energy content, natural gas was the majority share of Texas production at an average 53.4 percent; last year natural gas production rose to 74.3 percent.[1] We don't have an accounting of oil versus gas exploration by state, but with nearly 600 rigs working in Texas and fewer than 200 looking for oil nationwide, it is clear that Texas exploration is also now dominated by the search for natural gas.

Table 2 identifies which parts of Texas have been winners in this cyclical upturn and provides important clues about the role of natural gas in Texas' recent drilling success. The table uses the Texas Railroad Commission's geographic classification to divide Texas into 12 inland regions plus the offshore or inland waters. The numbers shown are the difference between the number of rigs working at the last peak in 2001 and in April of this year. Two measures of activity are used: the Smith and Baker Hughes rig counts.[2] A positive number indicates more drilling activity than 2001; a negative number indicates less.

There are two well-defined losers. The offshore, with a decline of 19 rigs according to both surveys, shares this negative trend with Louisiana and other offshore regions; the shallow waters of the Gulf of Mexico have seen a sharp decline in exploration. Deep South Texas, hot in 2001, has also cooled significantly. Meanwhile, East Texas, the Panhandle and a region north of Fort Worth defined by Districts 5 and 9 account for most of the increased drilling in the state. Altogether Texas has seen a net increase since 2001 of 58 rigs in the Smith count and 90 for Baker Hughes.

What these areas of hot drilling activity have in common is unconventional gas reserves—the Barnett shale near Fort Worth, the Cotton Valley and Bossier sands in East Texas, and other tight sands in the western Anadarko Basin of the Panhandle. Together they are instrumental in pushing the Texas rig count to recent high levels. New technology and high prices have brought operators into each of these areas in search of high margins and high returns in unconventional gas plays.

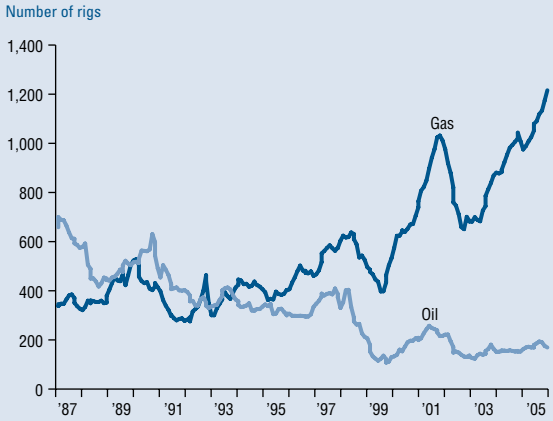
Unconventional Gas

Geologists call it continuous gas, but it is also called unconventional gas, blanket gas or even weird gas. Whatever you choose to call it, you must give it due respect for its growing importance. The Department of Energy reports the share of unconventional gas doubled from 17 percent of Lower 48 natural gas supplies in 1990 to 35 percent in 2003. By 2025 it is projected to be 44 percent—matching the role of conventional gas—with the remaining 12 percent of domestic supplies imported.

Unconventional gas is methane or another light hydrocarbon similar to that

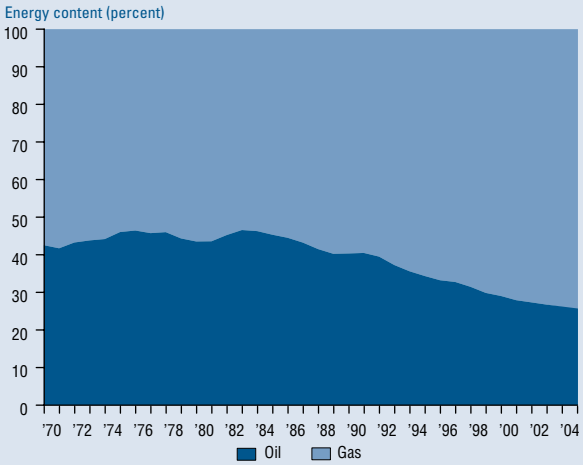
Figure 1

Working Rigs Directed to Oil and Natural Gas in the United States, 1987–Present



SOURCE: Baker Hughes; seasonally adjusted by the authors.

Figure 2
Share of Oil and Natural Gas Production in Texas, 1970–2004



NOTE: Based on gas valued at oil-equivalents in terms of energy content.

SOURCE: Texas Railroad Commission; authors' calculations.

found in the conventional anticlinal trap, but it is stored in the earth and produced differently. It is stored uniformly in a formation that extends over a wide area but is trapped in a rock formation that requires additional resources to free it. New technologies have been developed to drill, complete and stimulate these wells.

The first type of unconventional gas, tight gas, is trapped in an unusually impermeable sandstone or limestone formation. The problem is to get the low-permeability formation to release sufficient gas to flow in economic amounts to the well bore. Hydraulic fracturing was first developed in the 1940s and applied to tight formations in the 1970s. Water is injected under high pressure, cracking the formation and opening fissures that boost gas production by a factor of 10 or more.

Devonian shale is a second important form of unconventional gas. Shale is a nonpermeable rock, a clay compacted by pressure, where free gas is stored in the rock pores or in natural fractures. As with other unconventional types, the gas is stored continuously, and hydraulic fracturing is used to make it flow freely. Shale gas was produced as early as the 1820s in Appalachia—many years before the first oil well in Pennsylvania—and the Appalachian Basin remains a major producer today. Although research and technology have been important in producing all forms of unconventional gas, shale is particularly challenging; there is no universal formula for success in freeing the gas from the formation.

Coal-bed methane is the third form of continuous gas, and although it is relatively unimportant in Texas, neighboring New Mexico is a pioneer in developing these resources. Coal-bed methane is a by-product of the formation of coal from plant material, not a result of the high temperatures and pressures that turn organic material to the conventional natural gas found in structural traps. The coal-bed gas reserves remain trapped in the coal seams as long as the water table lies above it. To release the gas, a well is drilled and water is pumped out to lower the water table and release the gas to flow to the well bore. As the water table falls, the well produces less water and more gas over time. Coal-bed methane accounts for about 45 percent of New Mexico's production from the San Juan Basin, one of North America's most important gas fields.[3]

Development of technologies to successfully exploit unconventional formations was the product of tax credits offered on wells drilled from 1979 to 1993. Throughout the 1990s, subsidies on production from these wells paid about $1.05 per thousand cubic feet of unconventional gas delivered to market. The tax credits are gone now, but the technologies that were developed continue to lower the cost of delivering this gas, making it highly profitable at today's prices. Continuous gas wells typically have lower capital costs because they are shallower and use smaller rigs; in addition, there is little risk of a dry hole because the gas is uniformly spread over a wide area. The wells also tend to be long-lived, delivering large amounts of gas initially, tapering off and then stabilizing for 20 to 40 years.

Hot Plays in Texas

North Texas. One of the hottest drilling areas in the United States is in North Texas, centered in Denton and Wise

Table 2
Change in Texas Rig Count by District, 2001–Present

District		Smith rig count	Baker Hughes rig count
1	San Antonio	6	14
2	Refugio	5	6
3	Southeast	–2	7
4	Deep South	–34	–10
5	East Central	6	2
6	East Texas	41	37
7B	West Central	6	11
7C	San Angelo	7	8
8	Midland	–6	–7
8A	Lubbock	–2	–2
9	North Texas	15	9
10	Panhandle	35	34
Offshore		–19	–19
Total		58	90

NOTE: The comparison for rig counts is June 2001 to April 2005. Districts are defined by the Texas Railroad Commission.

SOURCE: Baker Hughes; Smith Tool Activity Tracking System; authors' calculations.

counties but rapidly spreading to Tarrant, Johnson, Bosque and other surrounding counties. The Barnett shale is an unconventional gas play, with the target shale 1,000 feet thick on the northern edge of the Fort Worth Basin. Typical drilling depth is 7,500 feet, followed by hydraulic fracturing. It is providing operators with very high margins at minimal risk in the current price environment.

Similar to most unconventional gas plays, the likelihood of a dry hole is quite low. The problem is to produce enough gas from impermeable rock to make the well economic. Mitchell Energy (later sold to Devon Energy) began developing methods in the 1980s to attack the shale economically. Aided by Section 29 tax credits, the company found the key factor in reducing costs to be using inexpensive water and sand to fracture the formation, instead of the much more expensive gels and sand.

The current commercially productive area extends over 50 square miles in Denton, Tarrant and Wise counties. As exploration moves west, it has been complicated by underlying, water-bearing formations, where fracturing poses the risk of pulling the water into the shale. The ultimate resources of the Barnett shale have not yet been assessed, but it seems certain to be among the 10 richest hydrocarbon systems in the world.

East Texas. The first economically significant oil production in Texas was at Corsicana in 1894. The development of the Corsicana fields in East Texas put the state on the map as a commercial oil producer and attracted the first oil skills to Texas. It set the stage for Spindletop in 1900. Waves of oilfield development have moved through the region many times since 1894, driven by price and technology. The current wave targets several continuous, tight-sand formations.

The Cotton Valley sand formation is found throughout East Texas. Important gas-bearing sandstone is found in the Overton field in Gregg, Rusk and Smith counties, for example, and in the Carthage field of Panola County.[4] The Cotton Valley sand has been developed since 1970, but current high natural gas prices have turned a marginal economic venture into an extremely lucrative pursuit. Current activity is driven by new cost-reducing technology, some new discoveries and significant infill drilling due to regulatory permission to decrease well spacing.

The Bossier sand of East Texas is a continuous play of multiple fields and multiple pay zones. Anadarko has been the chief operator in the Bossier sand, with a near 100 percent success rate in development. A typical well is 12,000 feet deep and initially produces 2 million to 4 million cubic feet of gas per day. More than 2 Tcf of ultimately recoverable gas has already been developed. Current activity centers on Freestone, Henderson and Anderson counties.

New development is also occurring in the Travis Peak formation in the Joaquin field of Shelby County. And in some areas, such as the Freestone Trend in Freestone, Limestone and Robertson counties, a single well can find multiple pay zones of Cotton Valley, Bossier and other sand formations.

Panhandle. Another venerable area seeing new development is the vast Panhandle Hugoton gas field. Oil was found in this field in 1915, but the extent of natural gas reserves in the region first became clear with a well drilled near Amarillo in 1916. The formation is part of the Anadarko Basin that covers much of Oklahoma and parts of Kansas, as well as encroaching on the eastern edge of the Texas Panhandle.

The Panhandle field has four major producing zones, and the lowest is an underlying disintegrated granite or granite wash. The Granite Wash play is currently focused on Wheeler and Hemphill counties on the Oklahoma border and covers more than 1,000 square miles of tight-sand formations. Like other continuous gas formations, the focus is less on discovery and much more on cost reduction in drilling and stimulating wells. Reduced well spacing, approved by the Texas Railroad Commission, in some cases with spacing as low as 20 or 40 acres per well, also explains the number of rigs working the region.

A prospective development in the Panhandle lies in Briscoe, Floyd and Motley counties, midway and just east of a line drawn from Lubbock to Amarillo. Several companies are actively leasing extensive blocks of acreage in the area, betting that sand and shale formations will develop into a major new producing area for unconventional natural gas.

West Texas. Although we have focused on areas where unconventional natural gas is a major driver for exploration, it plays a smaller but active role in other regions as well. None is better known as a black oil producer than the Permian Basin of western Texas and southeastern New Mexico. But even here, natural gas drives current exploration and production. The Canyon sand of the eastern Permian Basin has been producing since the 1970s with hydraulic fracturing, but it now has found new life with continuous gas technologies and high prices. The Morrow sandstones of eastern New Mexico became an important gas play in the 1990s,

as did the Ozona Canyon reservoirs and the Val Verde Basin.

Oil and gas exploration in the Permian Basin is currently about even with the 2001 peak. Interest runs high throughout West Texas in effective stimulation techniques for low permeability carbonates and sandstones and effective production from some regional shale.

Implications

Although unconventional activity now drives the Texas rig count, what would happen if the price of natural gas was $3.50 or less? No one is forecasting a drop in natural gas prices to $3.50 or less, but now that natural gas is in the driver's seat for Texas hydrocarbons, what would be the implications of a significant decline? Figure 3 summarizes the percentage contribution of oil and natural gas activity to the Texas economy, measured by its share of gross state product and nonfarm employment.

The gross product series is broken in 1997–98 by a change in the definition of the oil and gas industry, but the downward trend in the role of oil and natural gas is apparent in data for both absolute and percentage contributions. Gross state product is probably the best and most comprehensive measure of the role of oil and gas in the economy, as it captures wages, interest, depreciation, profits paid to owners of oil assets and significant taxes paid to all levels of government. Even in decline, the total gross product of Texas oil and gas in 2002 remained 32 percent larger than Texas construction activity and equivalent to 44 percent of all state manufacturing activity.

As a share of Texas nonfarm employment, oil and gas has slipped from 2.1 percent in 1990 to 1.5 percent in 2002. These are some of the best-paid jobs in the state. Oil and gas operators paid an average weekly wage of $802 in 2004, and oil services and drilling paid $723. This is significantly more than the average weekly wage of $556 for manufacturing, $353 for retail and $486 for finance.

A decline in gas prices would bring lower utility bills to consumers. Texas is home to a number of industries, such as petrochemicals, where natural gas is a large component of production cost. Lower gas prices would make these industries more competitive. Exactly this trade-off has been noted for the Texas economy and oil prices, demonstrating how the net benefit of high oil prices for a declining producing state like Texas has narrowed to a small positive in recent years.[5] No such calculations have been worked out for natural gas, but given the high level of current exploration for gas versus oil and the continued significant role of oil and gas extraction in Texas, there is the potential for damage to the state economy if the price of gas were to fall far enough.

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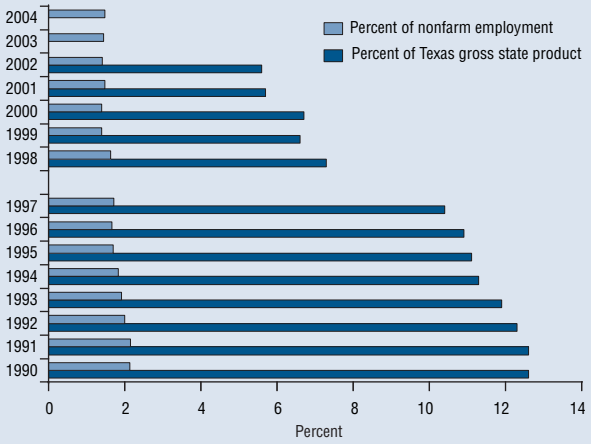
Figure 3
Contribution of Oil and Gas Extraction to Texas Gross Product, 1990–2004



NOTE: The definition of the oil and gas extraction industry changes in 1998 for gross product only. The latest data available for gross product are 2002.

SOURCES: Bureau of Economic Analysis; Bureau of Labor Statistics.

Notes

1 Figure 2 is based on energy content at approximately a 6:1 ratio for oil to gas (thousand cubic feet per barrel). If we use the economic value of oil to gas, the historic ratio is about 10:1. This would substantially improve the relative position of oil to gas in Figure 2 but would not change the trend to dominance by gas.

2 Both companies measure rig activity, but using different definitions. The Baker Hughes rig count measures activity by counting rigs with the bit "turning to the tight," at any stage focused on drilling operations between spudding in and target depth. Smith counts rigs drilling, rigging, fishing or at test depth, and any rig drilling during the week is included as active.

3 See "Unconventional Natural Gas Drives New Mexico Rig Count," by Robert W. Gilmer, *Crossroads: Economic Trends in the Desert Southwest*, Federal Reserve Bank of Dallas, forthcoming.

4 This section benefited substantially from "The East Texas Basin," by Peggy Williams, *Oil and Gas Investor*, February 2004, www.oilandgasinvestor.com.

5 "The Effect of High Oil Prices on Today's Texas Economy," by Stephen P. A. Brown and Mine Yucel, Federal Reserve Bank of Dallas *Southwest Economy*, Issue 5 (September/October), 2004.

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The green light is still glowing brightly for Houston's economy, with good news from the energy sector, retailers, purchasing managers, the job market and single-family housing. The local Purchasing Managers Index moved back over 60, even as the national index continued its slow decline to levels near the break-even level of 50.

Houston's job growth remains on the same steady pace of 1.5 percent that we have seen over the past 12 months. Oil extraction and oil service jobs have been growing faster than the overall economy.

Retail Sales and Autos

Houston retailers report nice improvement, with most stores on or ahead of plan in recent weeks. Department stores, especially upscale ones, are doing well. Discount stores, which have been performing well for some time, continue to report solid results. If there is one lagging area, it is furniture; big-ticket items continue to move slowly.

After two years of subpar auto sales, April saw a sharp turn for the better. Sales of autos and trucks in Harris County were up 19.3 percent over April 2004 and have risen 6.7 percent for the year.

Real Estate

Apartment rent and occupancy continue to be pulled down by the ongoing construction of new units, and although the local office market has seemingly bottomed out, any recovery will be slow. The central business district will be the last to recover. Positive momentum can be found in the retail sector, driven largely by rapid single-family housing development. Industrial construction continues apace, and rents and occupancy are improving slowly.

Existing home sales were up about 5 percent April to April, and new home sales were up 15 percent over the same period. Inventory of speculative homes was about 7 percent higher than a year earlier.

Energy Prices

Crude oil prices trended down from $55 to $50 per barrel during April, then turned around in May based on inventory news and the approaching driving season. Demand for gasoline slowed in April and May, but the real test comes with the summer driving season. Crude inventories grew throughout the period—they were 8 percent above the five-year average for late May—and gasoline inventories were 4 percent above the five-year norm.

Natural gas prices followed the price of crude, trending down from over $7.50 to near $6.50 per thousand cubic feet. Also weighing on natural gas prices were inventories that continued to grow, reaching 20 percent above the five-year average.

Refining margins remained at healthy levels. Capacity utilization on the Gulf Coast was hurt by several outages and was low for this time of year. Refined product imports rose to five-year highs.

Chemicals

Petrochemicals saw a break in the fevered price increases of recent months as the chemical market quickly moved into reverse. Demand slowed in Asia, and product backed up through the entire supply chain; spot prices fell for ethylene, polyethylene, polypropylene and styrene. Expecting further price declines, processors were running down inventories. The slowdown was not reported to be severe, but was unexpected. There was speculation that Chinese companies had bought ahead in the first quarter, hedging against higher energy prices.

Oil Services

The oil service market remains very strong, capacity is limited and pricing favors the service company. Domestic drilling was flat over the period, although Texas continued to see modest gains. The market continues to turn toward natural gas, with only 11 percent of rigs directed to oil in recent weeks. International drilling continues to grow, adding 40 rigs over the last quarter.

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