



Houston Business

A Perspective on the Houston Economy

*The Gulf Coast
petrochemical industry
has long been
among the world's
most competitive...
fundamentally because
of a plentiful and cheap
supply of natural gas
relative to oil.*

Petrochemicals and Natural Gas Prices: Short-Term Pain, Long-Term Concern

Houston and the Texas Gulf Coast are home to two important oil industries. The upstream exploration industry, consisting of the oil producing, oil service and oil machinery industries, celebrates an increase in the price of oil or natural gas as an incentive to greater exploration. In contrast, the downstream petrochemical and refining industries see higher oil and natural gas prices as an increase in the cost of doing business, since they must pass higher feedstock costs through to customers to maintain profit margins.

The Texas and Louisiana Gulf Coast is home to the U.S. petrochemical industry. The industry converts oil and natural gas liquids into intermediate products that become plastics or synthetic rubber. The major core facilities in the petrochemical industry are ethylene plants. Of the 40 U.S. ethylene production sites, 35 (95 percent of U.S. capacity) are in Texas or Louisiana. For both Houston and Texas, petrochemicals are always either No. 1 or No. 2 on the list of annual exports to the rest of the world. In Houston, chemicals, plastics and refining directly provide 50,200 jobs, compared with 78,300 in oil production, services and machinery.

The Gulf Coast petrochemical industry is based heavily on ethane, propane and other natural gas liquids, which make up 76 percent of the typical feedstock mix to regional ethylene plants. For most of the rest of the world the input mix is reversed, with the input slate heavily weighted to naphtha, gas oil and other oil-based products. The Gulf Coast petrochemical industry has long been among the world's most competitive, partly because of the region's strong infrastructure and

immediate access to the world's largest market for petrochemicals but more fundamentally because of a plentiful and cheap supply of natural gas relative to oil.

The recent run-up in natural gas prices, both absolute and relative to crude oil prices, is causing tremendous short-term economic pain in the petrochemical industry. While it is too early to determine how much of the current natural gas price increases can be ascribed to cold weather and how much to more fundamental changes in gas markets, it is widely speculated that future U.S. natural gas supplies may be priced higher for environmental and other reasons.

SHORT-TERM PAIN

The price of natural gas rose steadily throughout 2000. The spot market at Louisiana's Henry Hub passed \$3 per thousand cubic feet on May 12 and has not looked back. It surpassed \$4 on May 24, \$5 on November 12 and \$8 on December 12. For methanol and ammonia, products made directly from natural gas, the impact has been dramatic. As much as half the nation's methanol capacity and one-third of its ammonia capacity may already have shut down for economic reasons.

The impact of rising natural gas prices spills directly over into the natural gas liquids market. Ethane and some propane have fuel value and can be left in the gas stream along with methane to sell as natural gas. Alternatively, ethane, propane and butane can be processed into liquids to be sold as chemical feedstock. As the fuel value of methane doubles from \$2 to \$4 per thousand cubic feet, for example, the fuel value of liquid ethane doubles from 13 cents to 26 cents per gallon and propane doubles from 18 cents to 36 cents. Because chemical feedstock prices rise proportionately with gas prices, an ethylene plant or other chemical producer clearly has to offer more than the equivalent fuel value plus processing cost to induce a processor to remove the liquids and shrink the natural gas stream.

However, as feedstock prices have risen, the price of the ethylene product has risen much less. In the first half of 2000, ethylene contract prices rose by about 17 percent and spot prices by 36 percent, helped by strong demand and a string of ethylene plant outages. In the second half, ethylene prices reversed course, and by November contract prices were down 6 percent and spot prices 20 percent. With natural gas

prices marching steadily upward, cash margins slipped by more than 50 percent between June and November—well below levels the industry recognizes as encouraging reinvestment.

The ethylene price weakness reflects problems in both demand and supply. Demand slipped in the second half of 2000 as the U.S. industrial market (including such important ethylene markets as autos, housing and consumer packaging) stagnated. Auto production slipped 11 percent from June to November, other consumer durables fell 1 percent, and consumer nondurables and housing starts were flat. Weak ethylene demand was probably compounded by a long period of post-Y2K destocking, which pulled inventories back to normal levels and affected the long supply chain stretching from ethylene producer to final consumer.

On the supply side, capacity additions in the United States, the Middle East and Asia are putting further downward pressure on ethylene prices. An additional 8 million tons of ethylene capacity is expected worldwide this year, compared with demand growth that typically runs about 4 million to 5 million tons per year. Excess capacity is expected to weigh heavily on the market into 2003.

Poor profit margins and new, more efficient capacity coming on line are taking their toll. At year-end, plant shutdowns had removed about 5 percent of U.S. ethylene capacity from production and reduced operations another 5 percent to 10 percent, pulling operating rates under 90 percent.

LONG-TERM CONCERN

This winter has so far been marked by brutally cold weather that arrived early and then lingered in key natural gas markets in the Midwest and New England. Cold weather was the primary factor in pushing natural gas prices to \$5 per thousand cubic feet and beyond in November and December. But this upward pressure on prices also may be a symptom of more fundamental changes taking place in U.S. natural gas markets. The deregulation of natural gas in the late 1980s and early 1990s left substantial surplus production capacity on U.S. markets, a result common to other deregulated industries, such as airlines and trucking. This overhang of production, known as the "gas bubble," lingered through much of the last decade.

The typical pattern for crude oil and natural gas prices in the 1990s was a ratio of about

10:1 (for example, \$20 per barrel for oil and \$2 per thousand cubic feet for natural gas). Each year winter weather drove seasonal price patterns, with gas prices peaking in winter and sagging in summer, when storage was refilled to meet the winter peak. However, in recent years, the gas-bubble surplus seems to have yielded to strong demand growth stemming from two main factors. First, as environmental restrictions have tightened, particularly under the Clean Air Act, the demand for clean-burning natural gas has risen relative to oil. Fuel switching for economic reasons, as between natural gas and fuel oil under industrial boilers, for example, has become increasingly difficult as environmental permits have become more stringent. Second, there has been a dramatic shift in favor of natural gas for electric power production. Efficient combined-cycle generation technology, lower capital costs than for other fuels and the environmental advantages of burning gas have combined to make natural gas the electric power producer's fuel of choice. One result was last year's apparent difficulty in filling storage for the approaching heating season; instead of dipping, gas prices rose steadily through the summer, presumably as storage operators competed with growing electric power and other demands for natural gas.

Simple trends do indicate a potential long-term shift in the price of natural gas, with prices trending higher since the late 1980s. Through the first half of the 1990s, the gas bubble kept the ratio higher than the 10:1 rule of thumb. Then, particularly around 1997, the gas prices moved up, pushing the ratio lower. Winter weather and falling oil prices now have pushed the ratio from 7.3 on November 1 to under 3 by late December.

Most of the rest of the world relies heavily on naphtha, a light distillate found in oil, to produce ethylene. The U.S. competitive advantage in petrochemicals has been built on abundant and relatively cheap domestic supplies of natural gas. Oil and naphtha prices are determined in a global market, while U.S. and Canadian natural gas inherently has a regional market because of physical limitations in moving gas over long distances. As the environmental and other demands for U.S. gas grow, we see the potential for natural gas prices rising domestically, while oil prices will be determined largely in a bigger market and by unrelated factors.

When do rising natural gas prices begin to threaten U.S. advantage? It depends on what is

Table 1
Cost of Producing U.S. Ethylene: Oil Versus Gas as Feedstock

Price of ethylene (cents per pound)	Natural gas price (dollars per thousand cubic feet)	Crude oil price (dollars per barrel)	Oil/gas price ratio
4	1	10	10.0
7	2	13	6.5
10	3	17	5.7
16	4	22	5.5
19	5	27	5.4
23	6	30	5.0

happening to oil prices at the same time. Table 1 shows the cost of producing a pound of ethylene as oil and natural gas prices change. For example, if ethylene made from natural gas feedstocks costs 7 cents, the natural gas costs \$2 per thousand cubic feet; to produce 7-cent ethylene from naphtha, oil costs \$13 per barrel. For oil to have a cost advantage over natural gas at \$2, a typical level in recent years in the United States, it would have to cost less than \$13 per barrel. The \$17–\$22 crude oil price range in Table 1 matches natural gas prices at \$3–\$4, both producing ethylene at 10 cents to 16 cents per pound. The \$17–\$22 range is typical of U.S. light sweet crude prices over the past 20 years. Adjusted for inflation, 35 of the 60 quarters from 1985 through 1999 averaged prices in this range, with only eight quarters below \$15 and six above \$25. Table 1 tells us that U.S. natural gas at \$3–\$4 would remain just competitive with long-term oil markets at \$17–\$22, although the historical profit advantage the United States has held at \$2 would be lost.

Two completely different sets of circumstances, both arising in the last two years, pose a threat to gas-based petrochemicals, as illustrated in Table 1. Following the Asian financial crisis, crude oil prices plunged, bottoming out in December 1998 with light sweet crude at under \$10 per barrel while U.S. natural gas held near \$1.80. Naphtha-based ethylene producers briefly held the energy cost advantage until oil prices began to rise sharply through the spring of 1999. Currently, naphtha is seizing the advantage again, this time because of spiraling natural gas prices. Much of the spike is weather-related, making it unlikely that naphtha's current extreme competitive advantage will last much longer than it did in 1998.

(Continued on back page)

The Houston economy continues to expand at a solid pace. Revisions to employment data, now available for the first half of 2000, point to 3.5 percent job growth for the year. Employment growth has been running at a 3.2 percent annual rate over the past three months. While the U.S. Purchasing Managers Index fell to the lower 40s in November and December, indicating a near recessionary rate of contraction, the Houston Purchasing Managers Index reading of 58.8 in November points to a healthy rate of expansion.

RETAILING AND AUTOS

Local retailers saw holiday sales start slowly, but cold weather, heavy promotion and sale prices finally cleared the shelves. Advertising costs and discounted prices hurt profits.

November auto sales slipped behind last year's by 5.6 percent, although year-to-date sales for 2000 were still running 14 percent ahead of 1999. Dealers expected December would be another weak month.

OIL AND NATURAL GAS PRICES

Spot prices for light sweet crude peaked in late November and have declined by \$10 per barrel. U.S. crude and product inventories remain low, but Asian and European stocks have begun to refill and U.S. stocks are expected to fill soon. Oil product prices have

generally followed the price of crude downward, with the fall of heating oil prices interrupted by cold weather in the Northeast.

Refiners' margins have also slipped in recent weeks but remain healthy by historical standards. Refineries on the Texas and Louisiana Gulf Coast have operated at full capacity to take advantage of the good margins.

Natural gas prices soared with cold weather in key markets in the Midwest and New England, pushing as high as \$10 and \$11 per thousand cubic feet. Inventories were about 15 percent below the five-year average in late December.

DRILLING AND OIL FIELD MACHINERY

In recent weeks, the domestic rig count flattened out at about 1,100 working rigs, the Canadian rig count dipped in a normal seasonal pattern and international work continued to grow. Worldwide constraints on equipment, services and skills are imposing limits to the number of active rigs, although the projects undertaken are increasingly risky and lucrative for service companies. Respondents indicate an increase in pure exploration activity as less risky development projects are becoming exhausted. Competition for scarce oil field resources is driving up service prices and industry wages.

Petrochemicals and Natural Gas Prices

(Continued from page 3)

The long-term question, however, is whether the causes of this current gas price spiral—stronger demand for environmentally friendly fuel and natural gas-generated electric power—point to permanently higher prices in U.S. natural gas markets that increase the likelihood of long-term erosion of the Gulf Coast's competitive advantage in chemicals. Much of the industry's historical advantage of cheap feedstocks would be lost with natural gas in a \$3–\$4 range. The cost factor, combined with severe impending environmental restrictions on petrochemical operations in Houston and restrictions on nitro-

gen oxides that ultimately may be applied throughout the Gulf Coast, may cause the region's petrochemical industry to rethink its long-term viability before making billion-dollar commitments.

—Mark A. Eramo*
Robert W. Gilmer
Arved Teleki*

**Eramo is director of light olefins and Teleki is chief economist, Chemical Markets Associates, Inc., Houston, Texas.*

For more information, contact Bill Gilmer at (713) 652-1546 or bill.gilmer@dal.frb.org.

For a copy of this publication, write to Bill Gilmer, Houston Branch, Federal Reserve Bank of Dallas, P.O. Box 2578, Houston, TX 77252.

This publication is available on the Internet at www.dallasfed.org.

The views expressed are those of the authors and do not necessarily reflect the positions of the Federal Reserve Bank of Dallas or the Federal Reserve System.