Dynamic FORECASTING

Market Insights: United States Natural Gas

A Dynamic Analysis of the United States Natural Gas Market

July 1, 2009

MING Q309

Foreword

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Individual newsletter: $1500.
Annual subscription (four qtrly newsletters): $5000.

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Introduction

Market Insights: Natural Gas Q309 presents Dynamic Forecasting's first quarterly report on the US natural gas market. The objective of this and subsequent newsletters is to present a dynamic view of US natural gas prices at Henry Hub. By dynamic, we mean how prices will likely change over time and why? Price is the great communicator between suppliers and consumers. When prices are rising, it is telling suppliers to produce more and consumers to use less, and vice versa when falling. Yet price is not translated into more or less supply and demand overnight. We live in a physical world with significant human and technical constraints. Supplies must be found, drilled, and then produced. This takes months at a minimum and possibly many years or even decades. Similarly demand takes time to adjust to price signals. Consumers may very well simply use less as price rise but permanently changing capital and infrastructure takes significant time: years and decades.

The analysis presented here is based on a system dynamics type model of the US Natural Gas Market. System Dynamics is a modeling technique developed at MIT in the late 1950s and early 1960s that applies concepts from engineering feedback control theory toward modeling business and other social behaviors. From a system dynamics perspective, the natural gas market is viewed as a complex feedback system that supplies gas to a consuming public. Our objective is to explore how the feedback structures of the gas market will likely drive the evolution of supply and demand and hence the communication between the two: price.

The primary focus of each newsletter will be to present our current forecast of prices at Henry Hub. The time horizon will generally extend over the next one to three years. Each newsletter will also devote space to discussing some aspect of our analysis. In this first newsletter, we explore the history of commodity cycles and how one can view the commodity cycle from a system dynamics perspective. In our second newsletter, we will discuss how we model price. Over time, the reader should gain an understanding of the foundations underlying our work.

Historical Overview

This first newsletter begins with a review of recent history. Figure 1 on the next page shows the average spot price at Henry Hub since 2000 (solid green line). Prices have seen significant volatility since January 2000 but, in general, followed an upward trend until summer of 2008. Since last summer prices have dropped precipitously.

For the decade prior to 2000, prices were relatively stable near or below $2 per mmbtu.

What happened to change the stability of the 1990's market? The simple answer is many things: natural growth in demand (population and economic growth), a building boom in natural gas fired power plants, a gradual depletion of traditional fields, and a weakening dollar. With the balance between supply and demand constrained, prices went upward.

Occasional shocks such as hurricanes or severe weather or runs in oil prices drove significant volatility.

As expected, the industry responded to increasing price signals with considerable new development. Figure 2 displays active drilling rigs as reported by Baker Hughes. As can be seen, rig counts rose along with price. Although not shown, this increased development activity has led to a considerable increase in US production capacity.

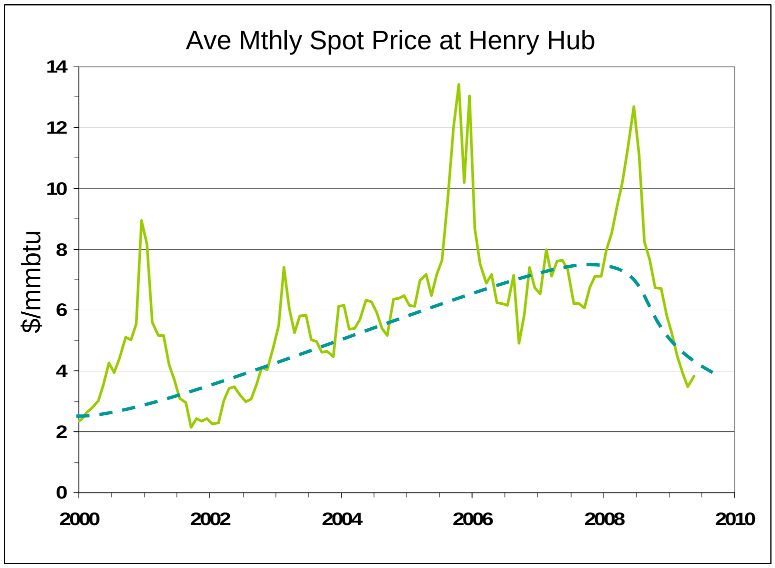

Figure 1: Historical Price

The growth in supply that has occurred in recent years now coincides with a severe recession that has curtailed consumption, especially in the industrial sector. Prices have sunk to levels not seen since 2002 and 2003.

To some extent the behavior of price, development and capacity follow a classic commodity cycle. The down cycle helped along by the recession. The question is where are prices going?

Before we present our price forecast, let's review the next chart. In Figure 3 we add a couple illustrative lines to show what we think is happening to the supply side of the market.

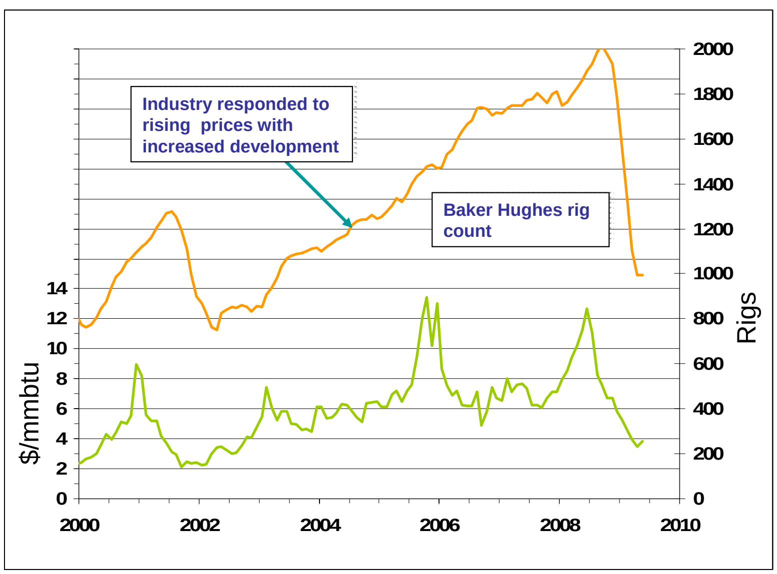

Figure 2: Historical Price and Rigs

Unfortunately, good data on US supply is not readily available. Rig counts are available weekly. Storage estimates are available weekly. Hub flow data can be obtained weekly. But none of this really informs us of what production capacity is. Hub flow data can provide a real time indication of production, but not the capacity to produce. Shut-in levels and absolute production capability is something that all traders must guess at.

The EIA's weekly storage report provides an estimate of how last week's production compared to last week's consumption, but it is difficult to divine from this data stream what the current state of supply or demand actually is. Perhaps, our blindness to the actual state of the market is why volatility rules.

What is the US industry's capacity to produce? Figure 3 provides an illustration of how production capacity is likely moving. According to Baker Hughes, active drilling rigs peaked in the fall of 2008. Production capacity will likely peak this summer. This is not an observable number as daily shut-in and production are not readily published or accessible pieces of information. However, the peak in production capacity will lag the peak in drilling for two primary reasons: 1) the delays in bringing newly drilled wells into production and 2) capacity continues to grow until new drilling falls below replacement levels, not simply off the peak.

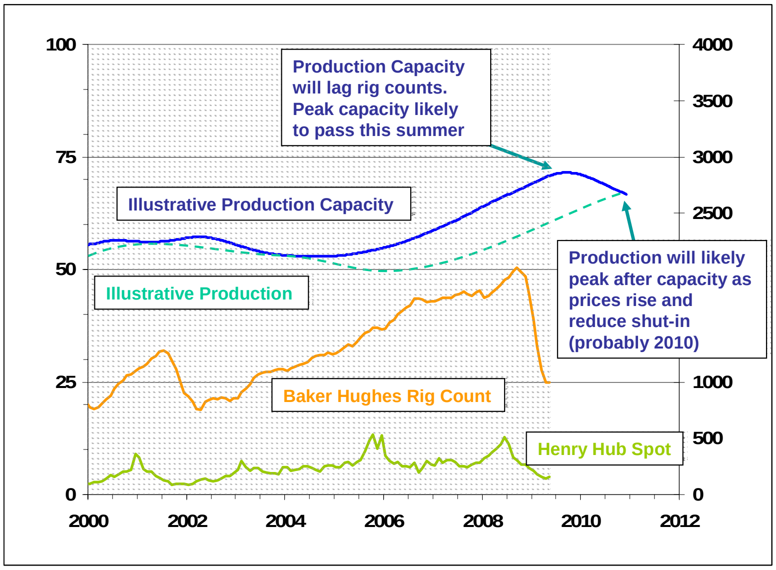

Figure 3: Illustrative Production and Capacity

In 2002 rig counts and drilling activity began to rise. However, production capacity probably continued to decline for another year or two. This is because existing capacity was degrading (being lost) faster than new capacity was being added. At some point, drilling activity exceeded degradation and production capacity began to rise. On the back side, drilling probably didn't fall below replacement (degradation) until late winter or spring. Add the delays to move drilling into production, and the capacity to produce is probably only now starting to fall (or soon to).

The capacity to produce and production are not the same thing. With prices low, the capacity to produce probably exceeds production by 5 to 15%. As the capacity to produce declines, that or other pressures will drive prices upward. As a consequence, peak production, for this cycle, is likely many months in the future. Rising prices in the fall or winter will drive production up towards capacity. However, at that point, capacity will be declining. We will never know what production could have been at the peak.

Price Forecast

Figure 4 below displays simulated prices at Henry Hub over the next year and a half. This chart represents our price forecast.

The chart below displays a probability distribution of prices. The distribution areas grow over time, indicating that uncertainty is accumulating as time progresses. Our basic assessment is that prices are likely to remain near their current values into the Fall. The month of July is likely to see declines, possibly bottoming out of this cycle. As discussed in the previous section production capacity is at or near peak, demand is weak due to the recession, and storage levels are at record levels for this time of the year. These things are likely to depress prices in July. August typically sees the heat of the summer and because of this summer prices are likely (as is common) to peak in August.

One point should be made in this regard. We expect gas usage for electricity generation to be above average this August, independent of whether temperatures in August are above average. Low natural gas prices will enable gas fired generation to subplant some coal fired generation this summer. At some point (possibly as weekly storage numbers come in low), this is likely to put upward pressure on prices.

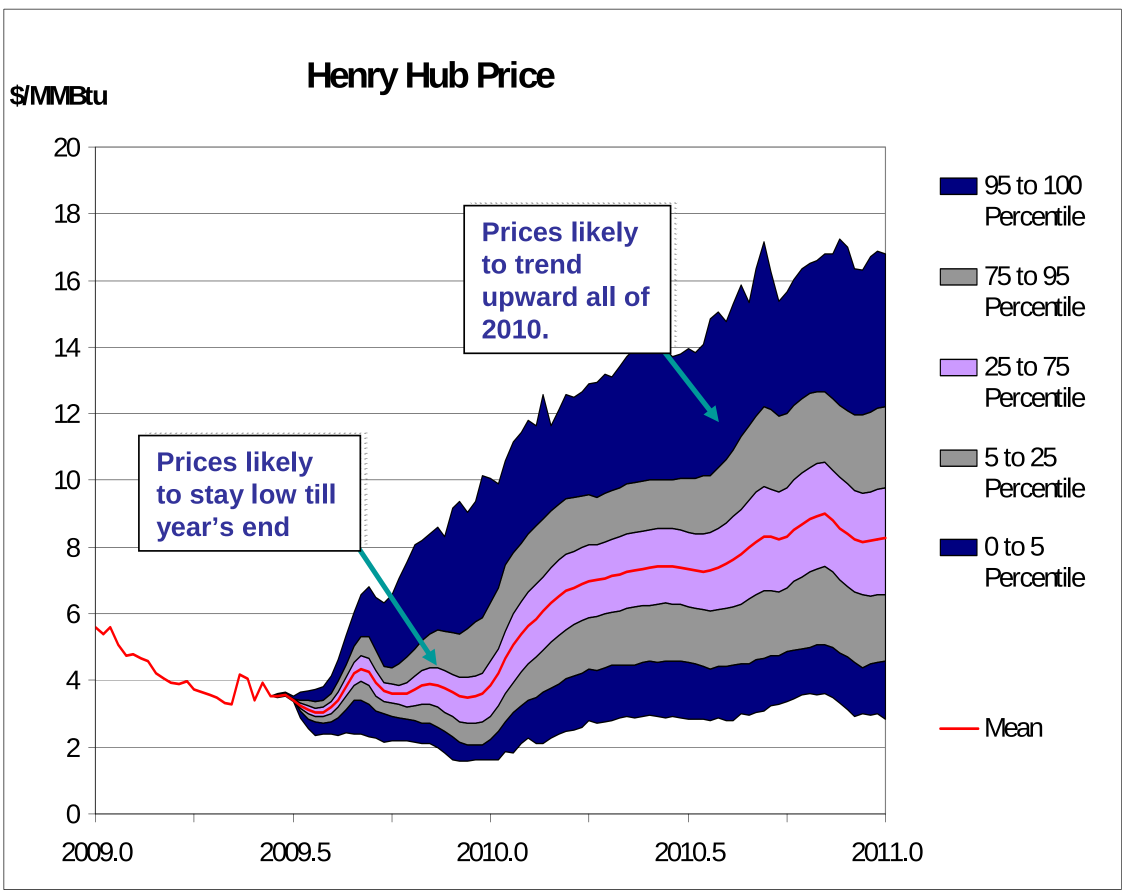

Figure 4: Simulated Price Distribution

Nonetheless, prices are likely to dip again in September and possibly throughout the Fall. This will be driven by: 1) storage levels, 2) weather 3) economic news and 4) oil prices. It may be that storage reaches capacity before the heating season. If this happens, spot prices may sink for a while. Although a run up in oil prices the last few months has not pulled natural gas prices up with it (although it probably has kept them from falling more), a run up this Fall would likely pull natural gas higher. Hurricanes or early heating load could keep prices above $4/mmbtu, but prices are likely to remain moderate during the Fall.

Although we expect prices to remain moderate for the Fall, at some point during the heating season, we expect an upward trend to develop. The drop in drilling activity will eventually be felt in prices. Declining capacity is likely to be recognized as the winter heating load develops. This will initiate an upward price trend that will remain all of 2010 and likely through 2011 (not shown).

Only a warm winter and a significant drop in oil prices would prevent this upward trend. On the other hand, a cold winter could see prices above $8/mmbtu

In review, we expect that the current price cycle will bottom with low prices either in July or before year's end. After that, we expect a multi-year upward trend.

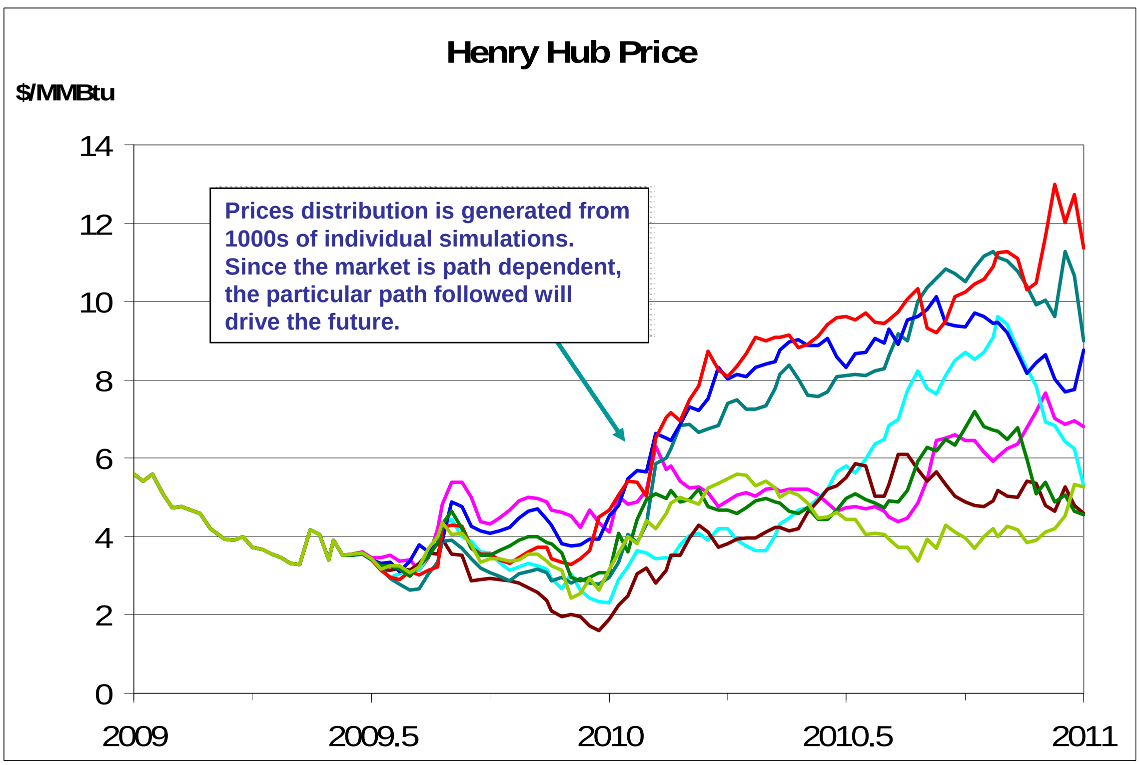

Figure 5: Simulated Prices, Sample Runs

As stated earlier, the Figure 4 presents a probability distribution of spot prices at Henry Hub. This distribution represents the spread of 5000 of individual simulations of

Dynamic Forecasting's Natural Gas Model. Figure 5 displays a sampling of individual simulations. The distribution shown in Figure 4 indicates the likelihood that a simulation passes through an area at a given point in time. It is not a probability that a simulation follows a particular path. A particular simulation may pass in and out of various probability regions, but at each point in time 50% of the simulations will be within the 25 to 75% distribution region.

Prices vary from simulation to simulation because some model inputs are treated stochastically (as random inputs). The primary stochastic inputs are: 1) weather (in terms of degree days) and 2) oil prices. Although a number of other inputs have stochastic components (coal prices, demand, imports, exports, etc.), these are secondary inputs and hence the randomness associated with them induces small variations in gas prices in comparison to degree days or oil prices. The core system dynamics model is deterministic.

Hence, the variation seen in simulations of Figure 5 is primarily the result of different weather scenarios and different oil price scenarios. Weather (degree days) are pulled from historically experienced patterns. Oil prices are treated as a random walk. A distribution of simulated oil prices is shown in the next section.

Stochastic Inputs

As stated, oil prices are a feed into our analysis. Price data is used for historical time periods simulated and a random walk is used going forward. Figure 6 displays the distribution of oil prices that is used in our analysis of future natural gas prices.

Oil prices have a variety of impacts in our natural gas model: both direct and indirect. There are direct pressures on simulated natural gas prices from oil prices. Rising oil prices put pressure on simulated gas prices to rise and falling oil prices put downward pressure on gas prices. In addition, oil prices affect the addition of drilling rigs, although substantially less than gas prices. A more indirect route is via the dispatch of oil fired or gas fired power plants to meet electrical loads.

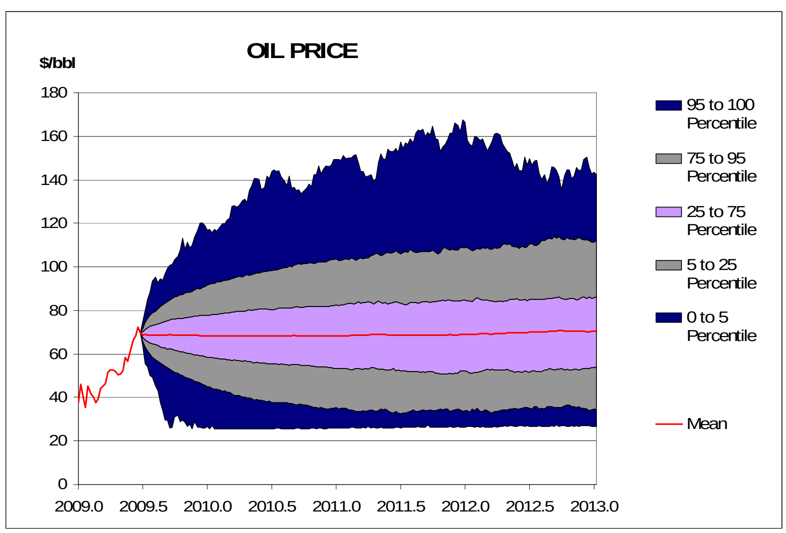

Figure 6: Oil Price Distribution

Coal prices are also a feed in the analysis. Like oil prices, data is used for simulated historical time periods and a random walk is used for going forward. Figure 7 below displays the distribution of coal prices used going forward.

Coal prices have a single impact in that they affect the dispatch of power plants to meet electrical loads. The relative prices of coal and gas will influence the degree to which coal or gas plants are used to meet electricity loads, thereby affecting natural gas consumption by the electric power sector.

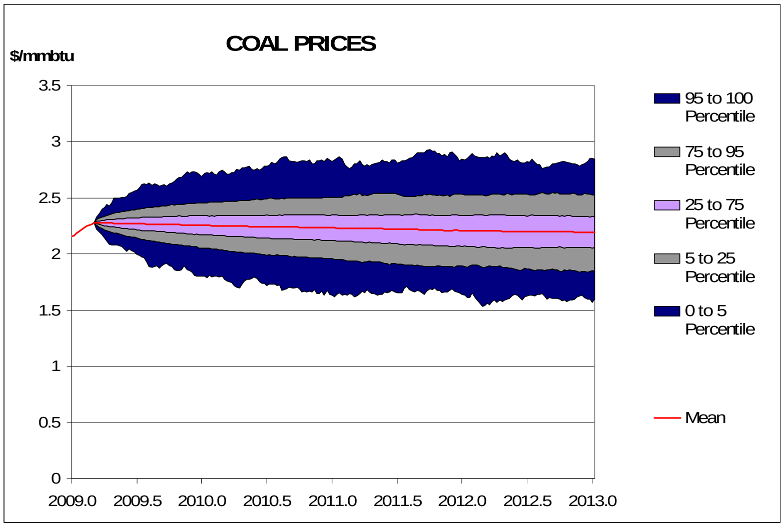

Figure 7: Coal Price Distribution

Commodity Cycles

The "commodity cycle", sometimes referred to as the "hog cycle", has been observed and studied for over half a century. In the 1930s, economist Nicholas Kaldor introduced the "Cobweb" theorem to describe a simple dynamic model of the cyclic movement of commodity demand based on the time lags between the response of production and changes in prices.[1] After this phenomenon was observed in US hog prices, it commonly became known as the "hog cycle." [2]

> *"**The basic economics of the hog cycle were simple**. The demand curve was downward-sloping, with demand quantity dependent upon the price at that point in time: there was greater demand for hogs when the price was low.*

[1] Kaldor, Nicholas. "A Classificatory Note on the Determination of Equilibrium", Review of Economic Studies, Vol I (February, 1934), 122-36.

[2] M Nerlove, 'Adaptive Expectations and Cobweb Phenomena', Quarterly Journal of Economics, vol. lxxii (1958), 227-40.

The supply curve was as usual upward-sloping, but with one difference: because of time lags in production, supply at a particular time depended on the price in earlier periods. In other words, when hog farmers brought their product to market it was based on historical prices. The time lags between supply and demand created imbalances which led to huge price swings. The same type of mechanism is at work today in energy."

Robert Feldman, Morgan Stanley
Financial Times, July 5, 2006

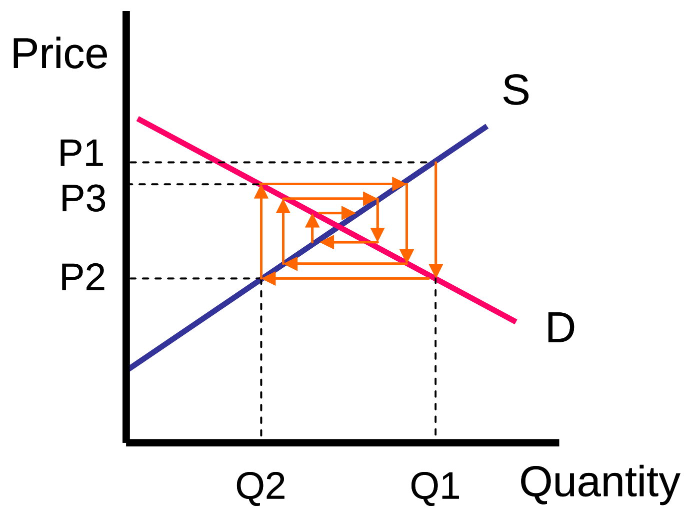

Figure 8: Cobweb Theorem

The basic idea of the cobweb theorem is shown in Figure 8. If for some reason prices rise to P1, producers will seek to produce quantity Q1. When Q1 comes on the market (after some delay), consumers are only willing to pay price P2. At price P2, producers are only willing to produce Q2. Once the supply Q2 is on the market, resources are somewhat scarce and consumers are willing to pay price P3. In theory this process would continue to bounce around until an equilibrium is achieved. The name "cobweb" derives from the chart's resemblence to a cobweb. The cobweb theorem describes the basic idea behind the commodity cycle: delays in the response of supply to price help generate oscillations in the marketplace.

Figure 9 displays a system dynamics perspective of the basic cobweb theory for the natural gas industry: a set of feedback loops describing the response of supply and demand to price. After prices rise to level P1, investment leads to more rigs and drilling activity -- following delays to perceive price changes, decide to invest, plan for increased activity and then execute such plans. After a sufficient number of successful wells have been drilled and hooked up to collection and processing systems, production capacity logs an increase to Q1. This causes the market balance to shift because more gas has been brought to the market to satisfy the original shortfall that had caused prices to rise. This additional supply exceeds demand at price P1. To clear the market, prices decline to

P2. At price P2 the supply feedback loop begins anew. This time the industry reduces investment, and ultimately production capacity declines to Q2. To clear the market at Q2 prices must rise to P3. At this point the supply feedback loop will drive another round. Although this discussion implies a somewhat discrete process, the reality is that the industry, consumers and the market are constantly perceiving changes in supply and demand so that the transition from P1 to P2 is a continuous process.

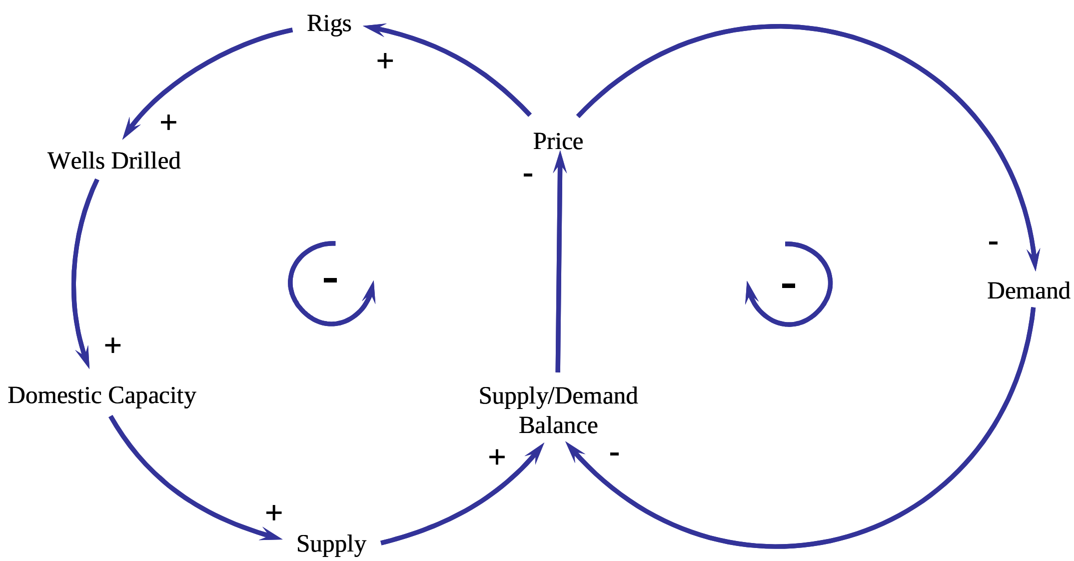

Figure 9: Primary Supply/Demand Feedbacks

The previous paragraph focused primarily on the industry's response. Prices drive demand to change as well. Demand changes can often be view in two components: short-term and long-term. This is because for such things as natural gas short-term price responses may be somewhat limited. Home owners may be able to turn a thermostat down when fuel prices rise, but they are unlikely to be able to switch fuels or make their homes more efficient in the short run. Of course, some consumers, especially industrial or electric sector consumers for gas may be able to initiate a strong short-term response. These consumers compete in markets where competitors may use other fuels or have access to less expensive gas. Hence, there may very well be a strong short-term response as production shifts to competitors with cheaper fuel or feedstock alternatives. Long-term price responses can be strong for all demand sectors. Existing capital stock can be replaced with more efficient versions or capital using other fuels altogether. Of course, this can take years, even decades.

The key to the commodity cycle is two fold: 1) the delayed response of supply to price changes and 2) the inability of the supply sector to truly know what prices will be. The length of the supply response delay is largely a function of the industry, its capital stock, the time to add capital, and the delay in recognizing prices changes and deciding to invest. The length of the cycle is largely a function of the response delay itself, how quickly or slowly capital stock depreciates, and how much demand is growing. The later two determine how long it takes an overshoot to bleed off; the first determines how large the overshoot will be. The inability of the supply sector to know what prices will be has many dimensions. One is that as prices change there will be a demand response. It is very difficult for the market to accurately estimate ongoing and future price induced demand changes. Another component is the delay in perceiving prices. Investments are based on future price expectations. Future price expectations are often grounded in recent prices, but it takes time to observe price movements and incorporate them into our expectations of the future. A complicating factor to perceiving prices is noise. Prices are noisy: they bounce around. Noise makes it more difficult to filter price movements and determine actual underlying trends.

These two features -- delayed supply response and faulty price expectations -- are common to most commodity markets and make the commodity cycle inevitable and ongoing. Both the supply and demand feedbacks are constantly active; the market never reaches equilibrium, even though it is constantly trying.