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Shale Gas Boom: Implications for California Agriculture

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Recent technological advances have unlocked vast supplies of domestic shale gas. As a result, the price of natural gas in the U.S. has plummeted. Cheap natural gas has the potential to provide cost savings for California's agricultural sector.

Over 31% of the fossil fuel energy consumed in the United States comes from natural gas—even more important than coal, which accounts for 25% of the total fossil energy consumed. Unlike coal and petroleum, which can easily be shipped around the world by vessel, natural gas is almost exclusively transported by pipeline. As a result, the vast majority (over 95%) of the natural gas consumed in the United States is produced domestically.

In the past, our natural gas largely came from conventional underground reservoirs located in soft rock formations. While these reservoirs provided easily accessible sources of energy, vast amounts of natural gas remained locked deeper in the earth's crust in hard, shale rock formations.

Over the last decade, however, there has been a revolution in the way natural gas is extracted from the earth. Hydraulic fracturing (fracking) has made it possible to unlock the vast shale gas resources that previously had been uneconomical to extract. Fracking involves injecting a pressurized mixture of water, sand, and chemicals into deep wells, typically drilled horizontally into shale formations. The pressurized mixture creates fissures in the rock layer, releasing oil and natural gas, which flows back up the well.

Many energy industry participants have described fracking as a "game changer." The technology is making cheap energy resources available to domestic consumers. It is clear that energy-intensive industries in the United States will benefit from fracking. However, it is less clear what the impacts will be on the agricultural sector and, specifically, farmers in California. Does fracking represent a "game changing" technology for the state's agricultural sector?

Growth in Shale Gas Production

In 2000, shale gas production accounted for only 1.7% of U.S. natural gas production (see Figure 1). Twelve years later, shale gas accounted for 35% of total U.S. production. By 2040, the U.S. Energy Information Administration (EIA) forecasts that over half of the domestic natural gas production will come from shale formations.

However, there is substantial uncertainty surrounding the forecasted shale gas volumes. In regions with large shale formations, very little exploration has been carried out to determine the potential amount of natural gas locked in the layers of shale. In addition, from

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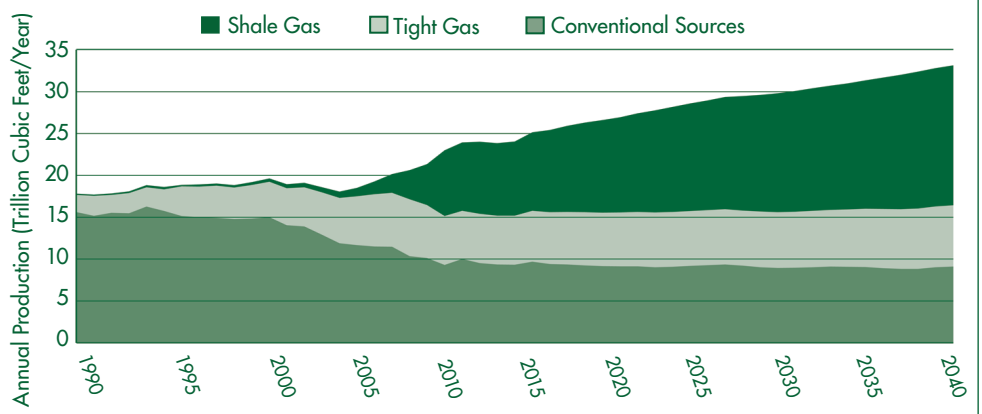
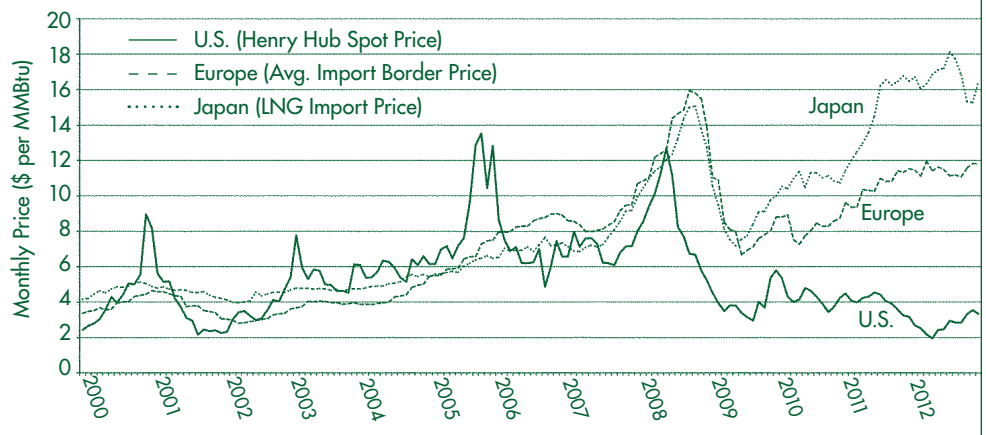
Figure 1. Projected U.S. Natural Gas Production



Source: U.S. Energy Information Administration (EIA) Annual Energy Outlook, 2013

Figure 2. Natural Gas Prices by Region



Source: World Bank

the sites where horizontal drilling and fracking is underway, very few years of production data are available.

There are very contentious debates surrounding the costs and benefits of fracking. In regions with rich shale gas deposits, substantial growth in employment and tax revenues are already being seen. For example, during 2011, Texas brought in $2.7 billion in severance tax revenue. A large portion of this came from the 7.5% severance tax levied on natural gas production. In states experiencing large budget shortfalls, fracking presents a very appealing revenue source.

While there are obvious economic benefits associated with shale gas, opponents of fracking are quick to point out that the technology could pose very serious risks to the environment. To extract gas from shale, millions of gallons of water, mixed with a variety of possibly hazardous chemicals, are pumped underground. The majority of the water remains in the well. However, up to 20% can be re-used for fracking in other wells or submerged into disposal wells. If not properly disposed, this mixture can contaminate surface waterways as well as groundwater.

On top of the threat of water contamination, there are also concerns arising from the impact shale gas will have on greenhouse gas (GHG) emissions. Compared to coal, the chief substitute for natural gas in the electricity sector, burning natural gas emits just over half as much CO2 per unit of energy created. Therefore, at first glance, it appears that expansions in natural gas production have the potential to deliver substantial reductions in GHG emissions and other air pollutants. However, recent reports from the Center for Atmospheric Research (NCAR) reveal that nontrivial amounts of methane—which compared to CO2, is a much more potent GHG—are leaked into the atmosphere during the process of fracking. As a result, the net GHG impacts of fracking remain a serious question.

Decrease in Natural Gas Prices

Despite the uncertainty surrounding many of the costs and benefits of fracking, there is one effect that is certain—the recent boom in U.S. shale gas production has significantly reduced the price of natural gas for the foreseeable future. In the past few years, the price of natural gas in the United States has fallen so much as a result of the fracking boom that increased U.S. gas flaring (due to the low gas price) in the Midwest is now visible from space at night.

Due to the fact that natural gas must be converted into liquefied natural gas (LNG) before it can be exported overseas, natural gas is not well arbitraged with world markets. Therefore, the U.S. price is now well below the European and Asian prices (see Figure 2). In June 2008, natural gas prices in the U.S. hit a high of $12.68 per thousand cubic feet and recently traded around $3.30. Current prices in Europe are close to $12 per thousand cubic feet.

In the long-run, two factors may reduce the spread between the international prices. First, while fracking was developed in the United States, the technology is now spreading to other countries in Europe, Asia, and elsewhere. If fracking can result in similar increases in natural gas supply overseas, regional prices outside of North America will likely experience similar declines. Second, with expansions in LNG production capacity, the price differential may be arbitraged in the future as international trade grows. However, for the foreseeable future, the gap in prices will likely remain.

Given the importance of natural gas in the economy, the shale gas boom is being viewed by many industry participants as a "game changer." The significant cost advantage that energy-intensive industries in the U.S. are now experiencing will certainly provide a competitive edge that will persist as long as the gap in international gas prices remains. But what does it mean for the agricultural sector and, in particular, the competitiveness of California's agricultural sector?

Impact on Agriculture

Low natural gas prices will have direct and indirect economic effects on California agriculture. The direct impact of lower natural gas prices on California's agricultural sector is likely small. According to the California Energy Commission, only 0.8% of total California natural gas consumption occurs in the agricultural sector. This is due to the fact that the majority of farm equipment runs on petroleum as opposed to natural gas.

Looking forward, if the relative price of natural gas remains below gasoline

and diesel, there could be a switch in the composition of technologies used on farms. For example, tractors running on diesel may be replaced by tractors powered by compressed natural gas. Additionally, with increased use of natural gas in the transport sector, the cost of moving products to markets may decrease. However, these long-run changes would not advantage California agriculture versus the rest of the nation.

Aside from the direct impact that low natural gas prices will have on the agricultural sector, there will also be two major indirect impacts. The first stems from the impact natural gas prices have on fertilizer prices. Natural gas is the main input in the production of ammonia, which in turn is the key input in the production of all nitrogen fertilizers. During 2010, 20.84 million tons of chemical fertilizers were used in the United States, of which nitrogen fertilizers accounted for 59%.

Recall from Figure 2, U.S. natural gas prices trended upwards from 2000 through 2006. These price increases had a direct effect on ammonia prices. From 2000-2006, the correlation between monthly U.S. natural gas and ammonia prices was 0.81. While natural gas prices increased from under $3/MMBtu to over $12/MMBtu, the ammonia prices paid by farmers increased by 130%—from $227/ton to $521/ton.

The low and stable natural gas prices being driven by the boom in shale gas production will put downward pressure on the price of ammonia. As a result, nitrogen fertilizers, as well as phosphate and potash fertilizers that serve as substitutes for nitrogen, will likely all experience price declines. These lower costs are a definite benefit for the agricultural sector as a whole.

However, given that fertilizers are arbitraged internationally, low ammonia prices will not directly provide a competitive advantage to certain regions. While regions with more fertilizer-intensive crops—corn, for example—will potentially benefit to a greater degree, a corn farmer in California and a corn farmer in Iowa will be affected very similarly.

Agricultural Electricity Use

The second major indirect impact low natural gas prices will have on the agricultural sector stems from the role gas plays in setting electricity prices. In the United States, coal and natural gas account for almost 70% of the total electricity produced. While coal is the dominant energy source—in 2011, 44% of electricity came from coal-fired units and 25% came from natural gas units—natural gas generators are primarily the marginal sources of electricity.

As a result, natural gas prices play a key role in setting the price for electricity in most regions. This is especially true in California where over half of the electricity generated comes from natural gas units. Lower natural gas prices directly lead to lower wholesale electricity prices. According to a recent report by IHS Global Insight, Inc, the decrease in natural gas prices resulting from shale gas production will result in an average reduction of 10% in electricity costs nationwide over the next 25 years.

Why are lower electricity prices significant for California farmers? The answer to this question lies in California's heavy reliance on irrigation for agriculture. According to the latest USDA (NASS) data, California irrigates almost 50% of the farmed acres in the state. The water application rate is roughly double the national average. This means that relative to other states, California is by far the largest user of water for agricultural purposes, measured by total acre-feet applied.

One of the largest determinants of the cost of water is electricity. In California, over 7% of the total electricity produced is used for pumping water and the agricultural sector. During an average year, California agriculture irrigates 9.6 million acres. This requires using roughly 34 million acre-feet of water of the 43 million acre-feet diverted from surface waters or pumped from groundwater. It takes more than 10,000 GWh of electrical power to pump and move this water.

Traditionally, California electricity prices are near the highest in the nation. Currently, only eight states have higher average retail rates. Due to California's heavy dependence on electricity for irrigation, farmers in the state could benefit greatly from lower electricity prices.

While lower natural gas prices have certainly reduced electricity generation costs in the state, this has not translated into lower retail electricity prices at this point. However, with natural gas prices remaining low into the foreseeable future, California farmers might soon begin to realize these benefits from lower electricity prices.

Conclusion

By lowering the price of natural gas, the recent boom in U.S. shale gas production has significantly changed the dynamics of the domestic energy market. These low gas prices are playing a key role in boosting the competitiveness of energy-intensive industries in the United States. Plentiful gas also has the potential to reduce the costs of key inputs in the agricultural sector. While fracking is not likely to provide a "game changing" competitive advantage to California farmers, the state's agricultural sector will certainly benefit if the lower natural gas prices translate into lower water and fertilizer costs.

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