New Alchemy: Oil and Water into Food

The incredible rally in a broad range of commodity prices has captured the imagination of many and is creating a cruel dilemma for policy makers who need to be concerned about inflation even as economic momentum wanes. The April G7 statement seemed to recognize that the volatility of the dollar may be aggravating the move and prompted them to seek more stable foreign exchange markets.

To a large extent, the G7 appear to have gotten what they wanted. A better two-way market for the dollar has emerged and the implied volatility for the dollar against the euro and yen has fallen. As the month of May draws to a close, the benchmark 3-month implied volatilities are below their 100-day moving averages.

Perhaps helped by talk that the CFTC could tighten position limits in the futures market, many commodity markets have pulled back. There seems to be short-term and long-term forces at work in the commodity market. The short-term factors, some of which are related to cyclical factors, appear to be essentially a disequilibrium of supply and demand functions, which includes the increased accessibility via ETFs and other funds for money manager of both the leveraged (e.g. hedge funds, commodity trading advisors, other speculators) and non-leveraged funds (e.g. pensions funds, insurance companies endowments).

People are responding to price changes. Car sales in the advanced industrial countries have generally fallen and smaller engine vehicles are being favored when purchases are made. Americans are driving fewer miles. In Paris, a new 30-minute free bicycle rental program has been launched. Farmers are planting more grain. The world output of wheat for example is poised to increase by 8.2%, with the US winter wheat crop (panted in the Oct-Nov 07 period) expected to be more than 17% larger than last year and the largest in almost a decade. Wheat prices are near nine month lows. The prices of corn, rice and soybeans have fallen this month.

The focus has generally been on the near-term growth and inflation implications of higher commodity prices. What is in danger of getting lost is the underlying dynamic between oil, water and food that has important long-term consequences.

There may not be a water futures contract, but it is a precious commodity and one that is becoming scarcer. The global use of water tripled in the 1950-2000 period and the water table is falling in countries that are home to half the world's population. Almost three-quarters of the water is used for irrigation and during the last half century, the amount of land being irrigated also tripled.

To grow a ton of grain requires 1000 metric tons of water (1000 cubic meters). In comparison it takes about 14 mln tons of water to make a ton of steel. Already the shortage of water has begun impacting agricultural practices. China's shortage of water is one of the factors behind the drop in grain production from the 1998 peak of 392 mln tons to 358 mln tons in 2005. That decline is larger than Canada's annual wheat harvest. Corn, which requires less irrigation that wheat or rice, is the only major grain for which China's output has not declined. Through its heavy demand for water, China reportedly is creating a desert the size of the state of Rhode Island every year.

Since grain is so water intensive, importing grain is an efficient way to import water. Countries that have a water deficit are likely to import grains. Already, Algeria, Egypt, Iran and Mexico import more of their grain. The band of countries from Morocco in the west through Iran in the east, with rapid population growth and rising affluence, and water shortages are among the fastest growing grain import markets. Some countries, like Israel, have now prohibited irrigation of wheat fields. Other countries, like Saudi Arabia, have been forced by fiscal considerations to cut subsidies to farmers.

Roughly speaking, 97% of the water on earth is salt water in oceans and seas. Two thirds of the remaining water is trapped in glaciers, permafrost and the polar icecaps. That leaves 1% of the water for everything else. Through the desalination process, salt water can be made fresh, but the process is very energy intensive. One estimate suggests, for example, that if China's water shortfall would be met fully by desalination, it would require almost a third of the world's annual oil output.

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Hydrocarbons are involved with food production more directly than the production of fresh water. The tripling of food output between 1950 and 2000 required not only the tripling of land being irrigated but a nine-fold increase in fertilizer. Non-organic fertilizer is largely a derivative of fossil fuels. It takes about 5.5 gallons of such fuel to restore a year's worth of lost fertility of an acre of eroded land.

Grain is increasingly used not to feed people but to feed livestock. In 1960, for example, Mexico used only 5% of its grain harvest to feed livestock. Now it is closer to 50%. Egypt used 3% of its grain to feed livestock in 1960, now it is a little over 30%. In the same period China's livestock increased their take from 8% of the PRC's grain harvest to more than a quarter. About 80% of the US grain harvest goes to livestock.

As the world's population grows (~70 mln a year) and there is greater prosperity, the demand for animal protein increases. Some animals are more efficient than others in converting grain to protein. Cattle on a feedlot (grain fed as opposed to grass-fed) require about 7 kilograms (roughly 15.5 pounds) of grain for one kilogram of beef. Swine are more efficient, with a 4 to 1 ratio of grain to meat. A chicken is even more efficient at a little more than 2:1. Herbivore fish are the most efficient by requiring less than 2 kilograms to produce a 1 kilogram of meat.

There is a clear long-term trend toward focusing on the most efficient producers of animal protein. Between 1990 and 2005, beef created on feedlots was flat, while pork production grew by 2.5% a year. Pork output surpassed beef in 1979 and in 1995 poultry surpassed beef. Poultry production grew 5% a year from 1990's 41 mln tons, to 80 mln tons in 2005. The output of fish farmers grew at an average rate of 10% a year between 1990 and 2003 to reach 42 mln tons.

Applying science to the production of food can also help boost output. The dispersion of technology, such as high yielding and fast maturing wheat and rice seeds (developed in Japan) and hybrid corn (from the US) can be helpful. Water can be used more efficiently, such as the drip irrigation that has been employed extensively in Israel, Cyprus and Jordan (though accounts for less than 4% of the US irrigation and less than 1% of China and India's irrigation.

Through various other applications of science, animals can become more efficient in converting grains to protein. Consider the chicken. In 1900 the average hen laid 30 eggs a year. Now she can lay 250 eggs or more a year. In 1900 it took 16 weeks for a chicken to come suitable for frying (weight of 2 pounds). Today a four-pound roasting chicken is ready in just six weeks. In 1930, it took more than six pounds of feed to yield one pound of broiler meat. By 1940 it required four pounds of grain. Today, less than two pounds of feed are needed. Now that is productivity.

Social organization is important too. Since the early 1970s, there have been cooperative ventures in India that allow farmers to pool their efforts and achieve economies of scale in various parts of the production of foodstuffs. In 1998, India surpassed the US in milk production, which now exceeds its rice harvest. In the 1970s, India produced a half cup of milk per capita. Now its production is more than a cup per capita and instead of feeding the cows the scarce grains, Indian farmers use wheat and rice straw and corn stalks. Cutting wastage, through things like cement storage silos on the farms themselves, also boosts the useable harvest.

There is a clear connection between water, grain, animal protein and oil. Irrigation of farm land is far and away the biggest use of water (~70%). Food production is also very energy intensive. Agriculture accounts for a full sixth of US energy consumption. Between 1945 and 1994, the US crop yield grew three-fold, but the energy input grew four-fold. It has reached the point of diminishing returns. Oil itself has become more energy intensive. In the 1940s, it took about one barrel of oil to get 100 barrels. Now that ratio is closer to 1:10.

At current production rates and given the current level of technology, some oil producers are projected to run out of oil in the next 10-15 years. Many countries are going to face severe water shortages. There are some pundits who suggest that the next wars are more likely to be over water than oil. As countries modernize, the desire for animal protein increases., but if every one would consume the 800 kilograms of grain (100 directly and 700 indicating through meat and other products) per person per years than the average North American does, the world's 2 bln ton harvest might only support 2.5 bln people. At the average Indian consumption level of 200 kilograms (nearly all consumed directly, little left for livestock feed), the current world's harvest can support about 10 bln people according to projections.

As Herb Stein famously put it: Any process that can't go on forever, eventually stops.

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