MARCH 2015 DISCIPLINED GROWTH INVESTORS

INFECTIOUS INNOVATION

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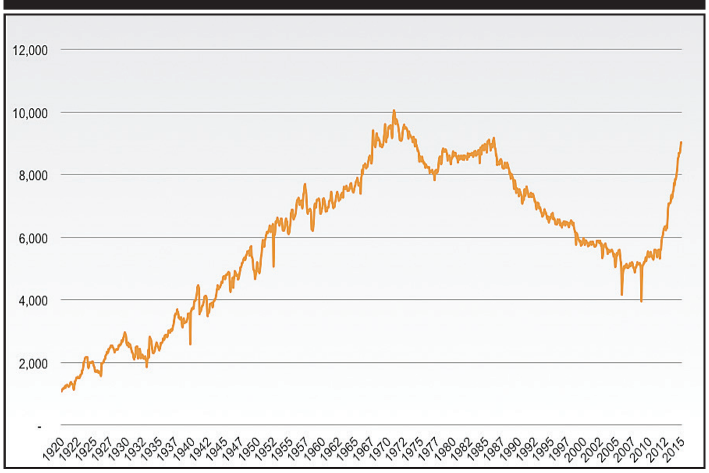
By Fred Martin, CFA, and Jason Lima, CFA

Our investment piece, "You Gotta Know When to Hold 'em", focused on innovation as the driving force behind the resurgence of corporate America. In that piece we discussed the profound effects from the confluence of three interrelated technologies and/or activities: computing, connectivity, and intelligent design. We also introduced the concept of "infectious innovation": the transformation occurring in industries not normally associated with innovative activity.

One prime example of infectious innovation we featured in our piece was the domestic oil and gas exploration industry. Recent data and events have validated the effects of massive innovation in that industry. The following chart shows daily crude oil production within the U.S. since 1920.

U.S. FIELD PRODUCTION OF CRUDE OIL
(THOUSANDS OF BARRELS PER DAY)

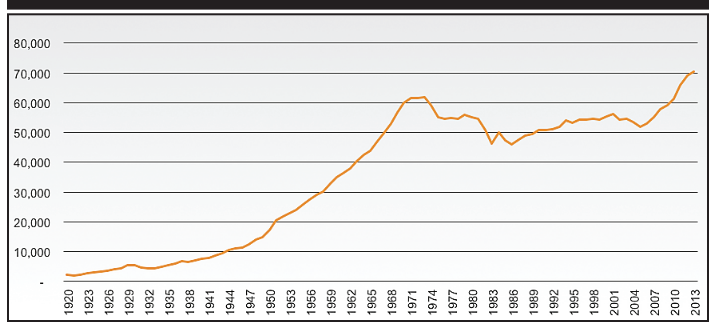


Source: U.S. Energy Information Administration

The chart above indicates U.S. oil production peaked around 1970 and began a long slide to about 4 million barrels per day (BPD) by 2007. Since then U.S. production has rapidly recovered and currently generates over 9 million BPD. U.S. oil production in 2015 is projected to increase yet again. This sea change in output is the equivalent of an economic tsunami.

You may recall the term "peak oil" became popular around 2006-07. The idea of "peak oil" was first introduced in 1956 by a geologist named M. King Hubbert. Using elegant math, Hubbert predicted that U.S. oil production would peak around 1970. Domestic oil production did peak in 1970 and declined for nearly four decades thereafter. Hubbert's forecast seemed to be sufficiently accurate to persuade investors, consumers, and politicians that the "peak oil" premise was valid. A natural extension of Hubbert's Peak Theory implies that oil prices would continue to increase.

U.S. NATURAL GAS MARKETED PRODUCTION
(MMCF/DAY)



Source: U.S. Energy Information Administration

In the early 1990's several independent oil producers began pulling together at least three technologies to develop commercially viable oil reserves – fracking, 3D seismic, and horizontal drilling. The possibility of finding significant amounts of oil was dismissed by all but a few industry participants. By the late 1990's Mitchell Energy began achieving stunning increases in reserves and production using the new technologies. For those interested in gaining more knowledge about these advanced processes, an addendum to this piece written by our own Jason Lima explains them in more depth. For those who want additional perspective, the book "The Frackers" by Gregory Zuckerman is worth reading.

Coincident with the popularity of the "peak oil" theory in 2007, oil production from fracking came of age. A prime example of this economic phenomenon has been the emergence of oil production in North Dakota, which has surpassed California and Alaska to become the second largest oil-producing state (behind Texas).

In 1798 Thomas Malthus wrote the following: "The power of population is so superior to the power of the earth to produce subsistence for man, that premature death must in some shape or other visit the human race." Hubbert's Peak Theory is a slightly more sophisticated version of the Malthusian theory, and both theories underestimated the effect of technology on advancing the human condition.

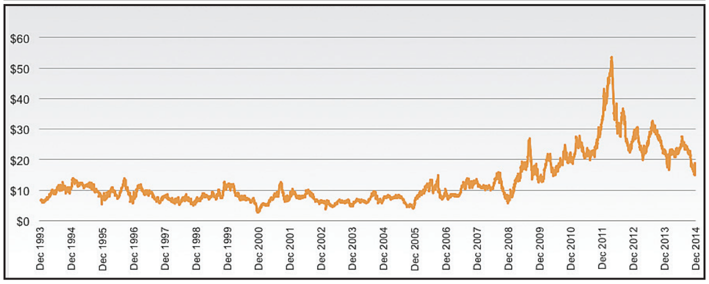
Hubbert used his methodology to venture beyond oil production forecasts, predicting that domestic natural gas production would peak in the late 1970's and decline similar to oil production. Hubbert's natural gas production forecast appeared initially correct but in the early 1990's began to grow again after experiencing only a modest decline. The following chart shows production of natural gas since yearly tracking data began in 1920. Readers will note that around 2010 domestic natural gas production achieved all-time record level and continues to increase.

Production of natural gas in the U.S. is even larger than production of oil. Based on energy equivalent basis, current U.S. natural gas production of ~70,000 million cubic feet per day (MMcf/day) is equivalent to approximately 11.7 million barrels of oil per day.

The relative difference in the production of gas versus the production of oil in the US since 1970 has caused distortion in the relative price of the two commodities. Since early 1993 the crude oil price per barrel has averaged about 10 times the natural gas price per thousand cubic feet (MCF). Beginning with acceptance of the "peak oil" thesis in 2007, the ratio between oil and natural gas expanded to nearly 50 times at the peak in 2011. The ratio has since settled back to about 20 times. Even though oil prices are set globally and natural gas prices locally, the current ratio of oil/natural gas prices means oil usage in the U.S. is vulnerable to substitution by natural gas.

The chart below shows the history of crude oil prices since 1989. Readers will note the sharp drop in oil prices in 2008 because of the economic recession. Oil prices recovered to around $100.

CRUDE OIL PRICE: NATURAL GAS PRICE



Source: U.S. Energy Information Administration

BBL until mid-2014, when prices began to slide. On November 27, 2014, OPEC declined to reduce output to protect the price of crude oil and the rout was on. We believe the OPEC decision was the most significant economic event of 2014.

We believe the decline in oil prices has short term impacts and the ongoing shale oil revolution has long-term implications.

WTI CRUDE OIL ($/BBL)
(THOUSANDS OF BARRELS PER DAY)

Source: U.S. Energy Information Administration

SHORT-TERM EFFECTS OF THE OIL PRICE DECLINE:

- A cut in basic living expenses for Americans. At current gasoline prices the U.S. consumer will save around $100 billion in gasoline costs, equal to about 1% of consumption.
- A significant cut in costs for oil-consuming industries. The most favored industry would be airlines; fuel costs are about 40% of revenues.
- A sharp drop in oil development activity.
- "Clean energy" is less competitive.
- Oil-related stocks have declined extensively.
- Inflation expectations in the U.S. have moderated.
- There is likely to be a shake-out among domestic/energy producers.
- There is intense economic pressure on oil-producing countries. Russia is a prime example. Since the November OPEC decision the ruble has collapsed. The chart below shows the exchange rate between the dollar and the ruble since 2005.

The longer oil prices remain under pressure the more sustained the long-term effects.

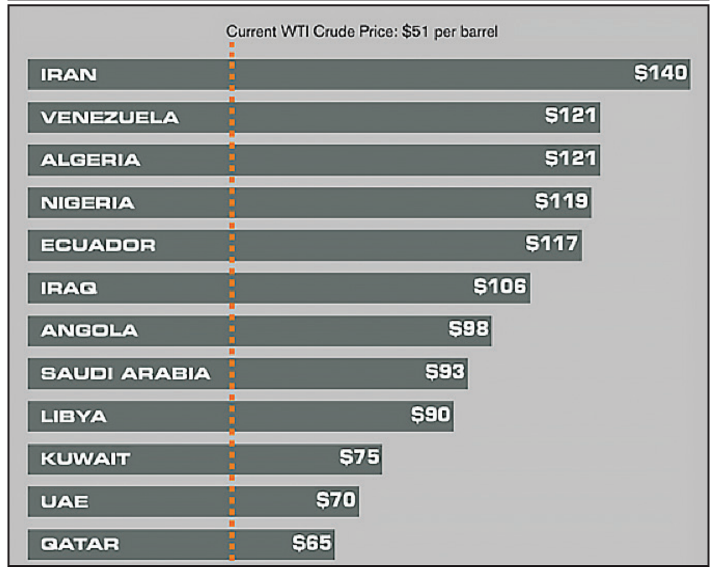
LONG-TERM EFFECTS OF THE SHALE OIL REVOLUTION:

- The concept of "peak oil" is probably obsolete.
- The long-term competitive landscape between oil/natural gas and "clean energy" is not clear. Both energy sources should benefit from innovation.
- Assuming the oil shale industry shows it can withstand the current decline in prices, the U.S. is likely to emerge as a formidable player on the world oil market. Unlike the other major oil-producing countries the U.S. oil business is a relatively small part of our economy. Even worse for other oil-producing countries, the overall U.S. economy benefits from weaker oil prices.
- If the price of oil remains elevated relative to domestic natural gas, there is likely to be significant substitution of natural gas for oil.
- The business "models" of existing major oil-producing countries are in trouble unless oil prices return to at least $100/BBL. Most major oil producing countries have expanded their social spending to levels which require very high oil prices. The chart next page, right shows the oil prices required to maintain the current rate of fiscal spending for some major oil-producing countries.

RUSSIAN RUBLE VS. U.S. DOLLAR
RUB/USD (U.S. DOLLARS PER RUSSIAN RUBLE)

Source: FactSet

FISCAL BREAK-EVEN OIL PRICES
CURRENT WTI CRUDE PRICE: $51 BARREL



Source: Wall Street Journal, Deutsche Bank, and the International Monetary Fund

INVESTMENT IMPLICATIONS

The oil price decline has caused a severe decline in the common stock of companies with oil-related businesses. This has opened up major opportunities for investment in those stocks. The damage to the oil-related stocks is similar to the extensive damage to nearly all stock in 2008, presenting similar opportunities for the patient investor. The common stock of domestic oil producers with excellent low-cost reserves and a commitment to aggressively reducing total production costs are likely to yield excellent long-term investment results. Companies providing unique services to oil producers should also yield fine results.

Recently we have been buying initial positions in oil-related companies that we believe meet our long-term criteria. Should our thesis prove correct we intend to increase our positions over the next couple of years. We note that we are not assuming a quick rebound in oil prices in our decision. We think it is more likely and more prudent to assume that our new holdings will have to cope in an environment of generally low oil prices.

The infectious innovation in the seemingly mature oil exploration/production industry underlines the growing importance of innovation in all industries. We are continuing to evaluate our existing holdings in light of the innovation opportunities/threats in their own businesses. And we are continually looking for innovative companies likely to change the landscape of their respective industries.

APPENDIX: A SHORT PRIMER ON CRUDE OIL AND HYDRAULIC FRACTURING ("FRACKING")

Conventional oil fields are usually contained within sandstone or limestone – these are types of rock that are highly porous and permeable; two properties which allow for the relatively easy extraction of hydrocarbons. Depending on the oil field's geological structure, conventional oil fields have the potential to be drilled and operated inexpensively, and may economically produce oil and gas for many years – the largest and most productive oil field in the world, the Ghawar Oil Field in Saudi Arabia, is the best example of one of the most ideal geological structures for oil. It has been producing since 1951, produces several million barrels per day, and is estimated to hold another 70 billion barrels in place. Anecdotally, the operating costs of the Ghawar field's wells amount to only a few dollars per barrel (Saudi Aramco does not publicly release data). The United States was not blessed with large, thick, and porous sandstone/limestone-based oil fields like those in the Middle East; however, what has been known by geologists for quite some time is that there exists a large amount of oil inside of shale formations in a number of locations within the U.S.

Ancient ocean basins which collected the organic runoff of rivers and estuaries are the genesis of these oil-rich shale formations. Over the course of millions of years, this organic matter would layer on the seabed along with mud, eventually hardening into shale with the organic matter trapped within. Like the oil formations of the Middle East, shale is highly porous; however, two common traits of shale have confounded its economic viability as a reliable energy source:

1. **Its low permeability makes oil extraction difficult because the molecules are too large to pass around the rock and be extracted through the wellbore.**

2. **The oil-bearing zones of shale formations are not very thick, but may extend horizontally for many miles. And the thickness and depth of these zones are not uniform. Vertical wells cannot economically extract oil in this manner even with fracking technology, as not enough oil can be produced to provide a sufficient return on the sunk cost of the oil well.**

Despite all the attention it receives, hydraulic fracturing only addresses the permeability problem. The first successful application of fracking was in 1949 and became relatively common for vertical wells. The fracking process is (simplified) as follows: After a hole is drilled and drill piping removed, steel casing is inserted into the wellbore. Next, a perforating gun is inserted into the casing to blast holes through the steel casing and into the rock, causing small holes in the shale formation. Fracking fluid, consisting of water, other chemicals, and sand or ceramic proppants is then pumped at high pressure down the wellbore. This creates fractures in the formation outside the holes of the steel casing. The fracking fluid is removed, with the sand and/or ceramic proppants left in place to keep the fractures open. The well is then ready for production.

The second property of shale, as described above, is addressed by a few other technologies: 3D seismic reflection, advanced computational power, and other advances in drilling equipment and drill bit location tracking. These technologies converged to allow for the precise targeting of oil-rich formations. The principal of seismic mapping is not unlike sonar, except that it is performed within solid ground: sonic energy waves are sent below the surface and reflected back at different speeds, depending on the type of rock formation encountered by the wave. Reflected data is gathered at the surface for processing; the more powerful the processor, the more detailed the subsurface picture. A geophysicist interprets the information, creating a three-dimensional image of the formations which indicate the precise location of hydrocarbons. Seismic reflection was developed in the 1930's, but its resolution advanced considerably with increasing computational power.

In the 1970's, oil producers began using directional drilling techniques. Initially, directional drilling involved entering the ground at an angle to increase the oil-bearing area in contact with the well; the drill bit still only went straight. Eventually, technology improved so that a driller could curve the drill bit from a fully vertical initial entry point. And drillers may also precisely target resource formations, knowing the exact location of the drill bit as it snakes through the best oil-bearing zones. As a result, one horizontal well can take the place of 5 or more vertical wells, greatly improving cost efficiency. These technologies have also enabled oil and gas companies to improve their economics by reducing the number of failed wells ("dry holes"). This failure minimization is extremely important because of a well's great cost – anywhere between $1 million and $15 million before the first barrel of oil is pumped.

It wasn't until the last decade when the confluence of all these technologies enabled the economic success of shale wells in the U.S. – hence, the shale revolution. Since then, experimentation and innovation have continued to increase yields and reduce costs for oil producers.

ABOUT THE AUTHORS

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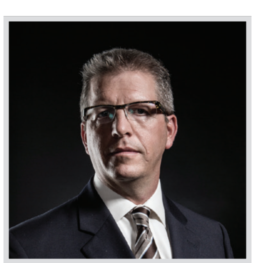

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