Geopolitical Implications of Shale Gas

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From Tunisia to Egypt and beyond, Tail Risk Issues are Related to Domestic Unrest

**Political contagion effect now a major component to oil price premium**

Post-Egypt, oil market faces new concerns related to the nature of domestic societies, economies, political leadership and “legitimacy” in key oil producing countries

- Contagion:
  - Many oil producing countries have experienced similar kinds of demonstrations and social unrest both recently and in the recent past
  - Saudi Arabia’s leading rulers are old and in failing health

**Over 21 million b/d of Middle East liquids production is at risk**

- Algeria: Median age 27.1 years, 10% unemployment, 2.1-m b/d
- Libya: Median age 24.2 years, 30% unemployment, 1.5-m b/d
- Syria: Median age 21.5 years, 8% unemployment, 0.4-m b/d
- Yemen: Median age 17.9 years, 35% unemployment, 0.4-m b/d
- KSA: Median age 24.9 years, 11% unemployment, 9.5-m b/d
- Iran: Median Age 26.3 years, 15% unemployment, 4.5-m b/d
- Iraq: Median Age 20.6 years, 15% unemployment, 2.8-m b/d
Jul. 26: U.S. debt stand-off turns into “dangerous game”

March 8: UN considers no-fly zone in Libya

Jan. 25: Mass protests in Egypt spark fear over Suez Canal closure

Feb. 17: Libya’s Day of Rage

June 8: OPEC meeting fails to reach a decision

Fall-out from OPEC Divide

Sep. 24: IMF highlights debt concerns

European Sovereign Debt Crisis

Escalation of Libyan Hostilities
Regime Change Often Followed By Production Declines
Sudden change of government results in worker unrest, brain drain, lack of a clear chain of command, and investment decision slowdowns, all of which can contribute to declining oil sector.
Iraq 1965-2009

- 1966: President Arif dies in helicopter crash; brother succeeds
- 1968: Baathist Coup; Bakr becomes
- 1979: Saddam Hussein
- 1980: Iran-Iraq War begins
- 1986-1987 "Tanker War" between Iran and Iraq
- 1988: Iran-Iraq war ends
- 1990: Iraq Invades Kuwait, prompting
- 1995: UN resolution to allow partial resumption of Iraq oil exports in
- 2003: US invades

Iran 1965-2009

- 1973: Iran nationalizes oil assets
- 1979: Revolution; Islamic Republic is formed under Khomeini
- 1986-1987 "Tanker War" between Iran and Iraq
- 1988: Iran-Iraq war ends
- 1996: Iran-Libya Sanctions Act
- 1995: UN resolution to allow partial resumption of Iran oil exports in
Democracy Does Not Necessarily Bring Higher Oil Production
Politics of competing political coalitions and stakeholders can slow investment process, siphon off funds from industry, and hinder decision making on complex technical projects.
Venezuela 1995-2009

- **1998:** Chavez elected president
- **2001:** Chavez announces oil industry reforms
- **2002:** Chavez appoints new board to state oil
- **2007:** Venezuela nationalizes part of oil industry by taking over operating control of oilfields operated by ConocoPhillips, Chevron, ExxonMobil, BP,

Mexico 1995-2009

- **2000:** Vicente Fox becomes President, ending 71 years of PRI rule
- **2006:** Calderon elected President of Mexico
There are critical unknowns about OPEC that could impact future balances.

- Will Iraq grow to 3.6m or 7.2m b/d? Or be thwarted by violence?
- Will Iran slide due to civil unrest or military conflict?
- Will Libya lose production potential?
- What will the politics of upstream investment be in Kuwait?
- Will Venezuela lose capacity?
- Will Nigeria stagnate or reverse course?

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Source for both figures: EIA, Credit Suisse Global Commodity Research
What has the “shale revolution” meant?
A Paradigm Shift

The view of natural gas has changed dramatically in only 10 years. Most predictions were for a dramatic increase in LNG imports to North America and Europe. Today, growth opportunities for LNG developers are seen in primarily in Asia.

Demand for natural gas appeared to be far from regions that had large resources. Now, it is becoming clear that shale gas will be available exactly “where the lights are on,” that is exactly where end-use demand is expected to be highest.
Prior to 2000, it looked like large natural gas reserves were far from end-use markets and LNG would have to come to North America to meet rising demand.
New World Vision: Shale will alter the energy security picture for major end-use markets, limiting individual producer petro-power and creating a more competitive marketplace for LNG.

Major North American Shale Plays (~1,930 tcf)

European, Latin American, African and Pacific Shale Plays (~4,670 tcf)

*Over 6,600 tcf of shale according to ARI/EIA report, 2011
Reference Case: Composition of U.S. Production, 2010-2040

- U.S. shale gas production exceeds 50% of total production by 2030.
- Canadian shale gas production grows to 1/3 of total output by the mid-2030’s (not pictured).
Reference Case: Need for U.S. LNG Imports Virtually Eliminated for Two Decades

- Very low re-gas terminal capacity utilization through 2040.
U.S. LNG Imports Without Shale Gas

- Absent shale resources, U.S. LNG imports rise substantially.
RoW Shale in the RWGTM

- As knowledge continues to advance, more shale plays may become commercial targets.
- The RWGTM currently only allows 800 tcf of recoverable resource outside the U.S., meaning we allow only a fraction of the recent ARI technical assessment to be commercial.
Shale gas delays heavy reliance on Middle East Gas for decades

World Supply by Region, 1990-2040 (Reference Case)
• Russian opportunities to Europe are diminishing as a result of shale production growth and Europe’s increased pull on LNG.

• The market share of Russia in non-FSU Europe falls to just over 13% by 2040, while it rises then stabilizes at just over 12% in Northeast Asia.
Reference Case: LNG Imports to Asia 2010-2040

- Strong demand growth means Asia is the major destination for future LNG exports.
  - China leads in LNG import growth despite growth in both pipeline imports and supplies from domestic unconventional sources.
Center of the Energy World Shifting Back to the Americas

Unconventionals Changing Global Energy Landscape
Onshore growth (Bakken, Eagleford, Niobrara, Permian) provides base for growth; Williston Basin production is expected to climb to 900,000 b/d to 1.2-m b/d by 2015; Eagleford to >450-k b/d, with more growth in Niobara play and Permian Basins. New estimates as high as 3 million b/d of oil liquids by the 2020s.

- US Gulf Of Mexico could add upwards of 2 to 3 million b/d
- US CAFÉ Standards could shave 2 to 3 million b/d off US oil demand by 2025
- US could once again become largest producer in the world

Source for charts: Credit Suisse
– **Investment focus likely to shift to unconventional oil if prices remain high.**

### Much Unconventional Oil Outside Middle East

<table>
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<tr>
<th>Country</th>
<th>Total Technically Recoverable Unconventional Oil (billion bbl)</th>
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<tbody>
<tr>
<td>USA</td>
<td>801.7</td>
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<tr>
<td>Canada</td>
<td>500.0</td>
</tr>
<tr>
<td>Other South America</td>
<td>525.9</td>
</tr>
<tr>
<td>Russia</td>
<td>160.3</td>
</tr>
<tr>
<td>Caspian</td>
<td>124.3</td>
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<tr>
<td><strong>World</strong></td>
<td><strong>2129.5</strong></td>
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Source: World Energy Council
Shale oil will be important in the long run: Might be hastened and expanded if current trends prevail.

### Base Case Baker Institute Forecast U.S. Oil Shale Production

<table>
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<tr>
<th>Year</th>
<th>Unconventional Production (million b/d)</th>
<th>Total Production (million b/d)</th>
<th>Percent of Total Production</th>
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<tr>
<td>2035</td>
<td>0.01</td>
<td>3.6</td>
<td>0.2%</td>
</tr>
<tr>
<td>2040</td>
<td>1.2</td>
<td>4.6</td>
<td>26.1</td>
</tr>
<tr>
<td>2045</td>
<td>3.8</td>
<td>7.3</td>
<td>52.1</td>
</tr>
<tr>
<td>2050</td>
<td>7.3</td>
<td>10.9</td>
<td>67.0</td>
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</table>

Note: Production from oil shale primarily comes online around 2035 (according to the model). The figures in the table do not include shale oil from the Bakken formation, for example, which approach about 900 thousand bbl/d then slowly decline after 2020.
Source: Hartley and Medlock, Rice World Energy Model, 2010
Players in Brazil have Ambitious Longer Term Goals

- Project delays, like in GoM, may slow production

OGX Production Targets

- Initial Production Expected to Begin in Early 2011, ahead of schedule
- CAGR of 70% from 2011 to 2019
- 1st FPSO already secured for a period of 20 years, at an average daily rate of US$253,000

Source for all charts: Credit Suisse
Geopolitical Repercussions of Expanded U.S. Shale Gas Production

• Growth in U.S. shale gas output has turned expectations upside down in less than a decade. In fact, rapid growth in shale gas production...
  – virtually eliminates U.S. LNG imports for at least two decades
  – substantially reduces Russia’s market share in Europe from 27 percent in 2009 to 13 percent by 2040, reducing the chances that Moscow can use energy as a tool for political gain
  – reduces the future share of world gas supply from Russia, Iran, and Venezuela; without shale discoveries, these nations would have accounted for about 33 percent of global gas supply in 2040, but with shale, this is reduced to 24 percent.
  – reduces the opportunity for Venezuela to become a major LNG exporter and thereby lowers long-term dependence in the Western Hemisphere and in Europe on Venezuelan LNG
• ... growth in shale gas production...
  – reduces competition for LNG supplies from the Middle East, thereby moderating prices and spurring greater use of natural gas, an outcome with significant implications for environmental objectives
  – reduces U.S. and Chinese dependence on Middle East natural gas supplies, lowering the incentives for geopolitical and commercial competition between the two largest consuming countries and providing both countries with new opportunities to further diversify their energy supply
  – limits Iran’s ability to tap energy diplomacy as a means to strengthen its regional power or to buttress its nuclear aspirations
But, nothing is certain...

- In general, multiple issues face shale development: some are global, some are not.
  - **Market Structure** – transportation regulatory structure (unbundled access vs. incumbent monopolies); bilateral take-or-pay obligations or marketable rights; existence of gathering and takeaway capacity and hurdles to development; competing resources (RPS, coal, nuclear, etc.); pricing paradigms; etc.
  - **Water** – volume and availability for production; water rights and resource management regulation; flowback options (recycle and/or treatment and disposal) and native infrastructure; concerns about watershed protection during drilling operations (casing failures and fracture migration); etc.
  - **Resource Access** – mineral rights ownership; acreage acquisition; resource assessments; environmental opposition; etc.
  - **Other issues** – earthquakes related to disposal injection of produced water; long term environmental effects of methane (and other gases) escape; concerns about potential chemical and/or radiation contamination from produced water; ecological concerns related to land use and reclamation; etc.

- A stable regulatory environment that fosters responsible development of domestic resources is critical to achieving the potential benefits presented by shale.

Kenneth B Medlock III, Rice University
Shale gas production in China grows to about 15% of the domestic market, but LNG is by far the largest single source of natural gas supply to China out to 2040.

Water will likely play a major role in Chinese shale production endeavors, as indicated by the fact that known shale plays are coincident with regions where water stress is already high.
China High Shale Scenario Case:
LNG Imports to Asia 2010-2040

- If China could develop its own shale rapidly, window for LNG imports would significantly shrink
China High Shale Scenario Case:
LNG Exports by Country 2010-2040

- Exports from Iran, Venezuela, Qatar and Russia most affected
Outlook for Shale Gas Impact on LNG Markets based on Baker Institute Scenario Analysis
LNG Exports: North America in a Global Context

- North American resources are large, but must be placed in a global context.
  - Multiple forces are at work: cost reduction and exchange rate movements.
  - Former Soviet Union (FSU) and Middle East (pictured for comparison) are larger and generally less costly. Access, transportation costs and the value of the dollar make North American resources preferential in the short-to-medium term in North America.

Cost reductions and higher recoverable resource estimates benefit the US supply picture.

A weak US$ lifts $-denominated costs outside of the US, which makes exports look attractive.
Two recent working papers indicate the exchange rate plays an important role in the determination of:

- The spread between oil and US gas prices (Medlock and Hartley (2011))

Key Points:

- Exchange Rate (XR) is vital to the stability of the relationship.
- Dynamic adjustment is sensitive to seasonal factors.

Example: The cointegrating (or long run equilibrium) relationship between crude oil and natural gas prices for different US$ values.

<table>
<thead>
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<th>XR (US$ vs Major Cur)</th>
<th>HH ($/mmBtu)</th>
<th>Oil Price ($/bbl)</th>
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<td>Average</td>
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<tr>
<td>current</td>
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Actual HH: $4.55

Implication: LNG exports are at least partly an exchange rate arb. This begs the question, “What happens to the oil-gas price ratio if the US$ strengthens?”
Henry Hub Price, 2010-2040

- Prices tend to rise over time as lower cost supplies are depleted. But, abundant shale gas resources render the domestic supply curve to be relatively flat.

- Scenario 2 is a sensitivity that shows no Shale development
- Scenario 3 is a sensitivity that shows no Shale in the Mid-Atlantic region