

A Discussion of US LNG Exports in an International Context

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Far-reaching implications of shale gas

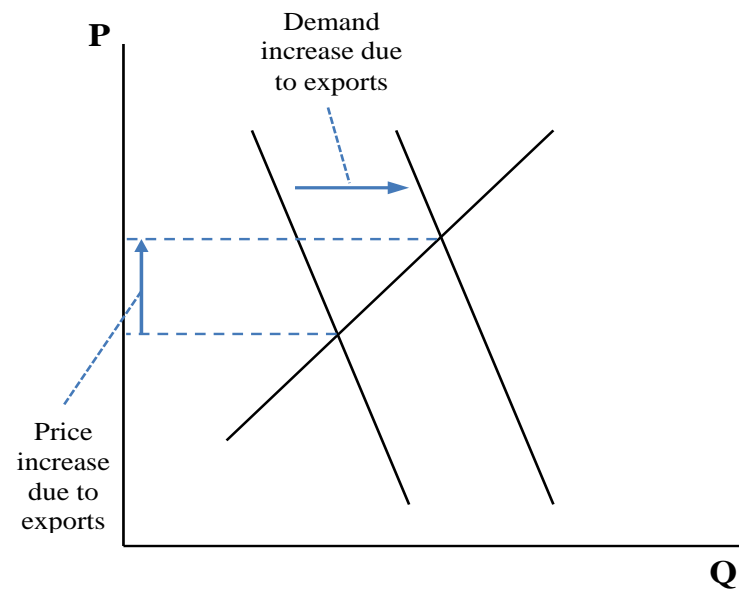
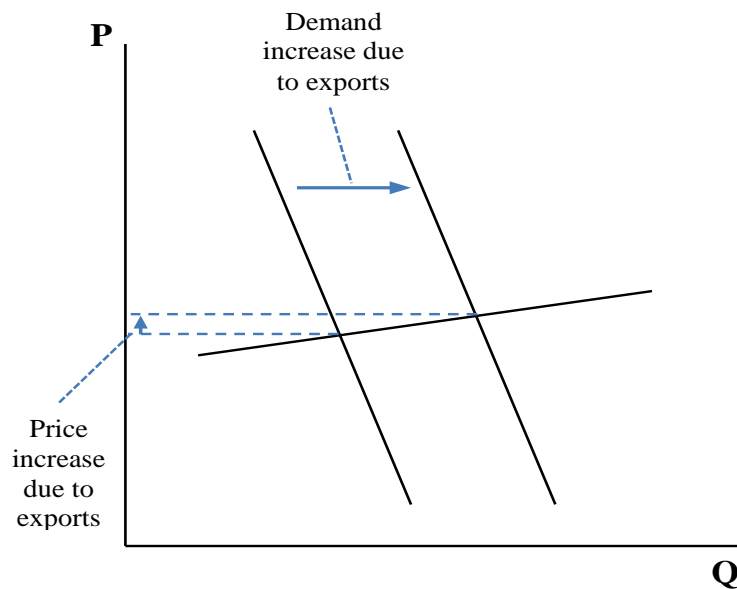
- Expansion of production from shale plays has rendered the utilization of LNG import capacity in the US very low.
- **It has also had an impact on the relative price of oil and gas, and**
- **... it has raised the possibility of US LNG exports.**
 - Domestic price impacts are a central concern, but will not likely be large given domestic elasticity of supply.
 - Recent work by Hartley and Medlock (2012) indicate this apparent opportunity may be highly contingent on the value of the US dollar.
- Current and potential future expansion of shale gas in the US, Europe and Asia effectively makes the *global* natural gas supply curve more elastic.
 - This mitigates the potential for sustained long term increases in price.
 - Greater supply elasticity also pressures traditional pricing paradigms.

The Prospect of US LNG Exports

Domestic Price Impacts of US LNG Exports

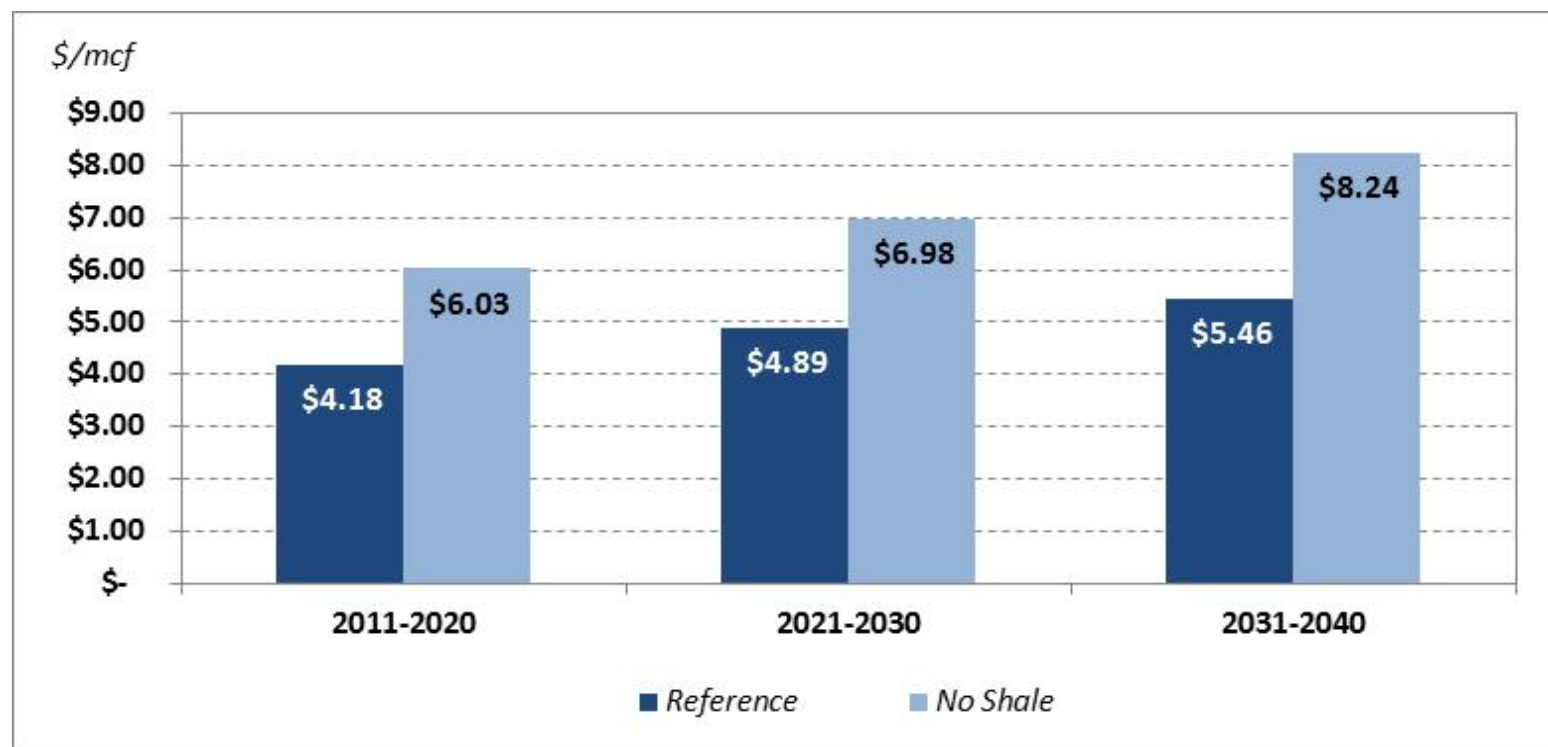
- Common claim: US price will increase substantially
 - Only true if US domestic supply is highly inelastic (pictured below) and foreign supply is highly elastic (not pictured). This claim is unlikely.

The Elasticity of Domestic Supply and the Impact of Exports on Price



Impact of Shale on Henry Hub, 2011-2040

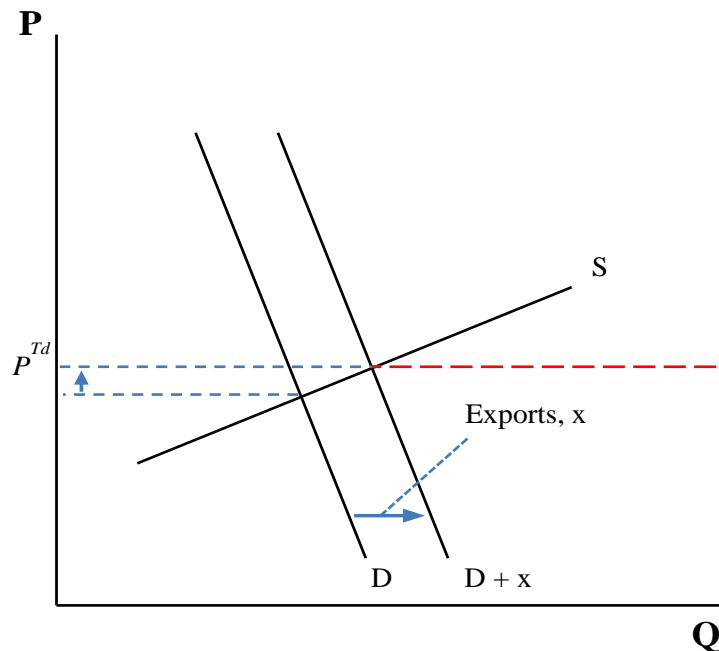
- The domestic supply curve is much more elastic as a result of shale gas developments. Domestic long run elasticity*
 - with shale = 1.52; without = 0.29.



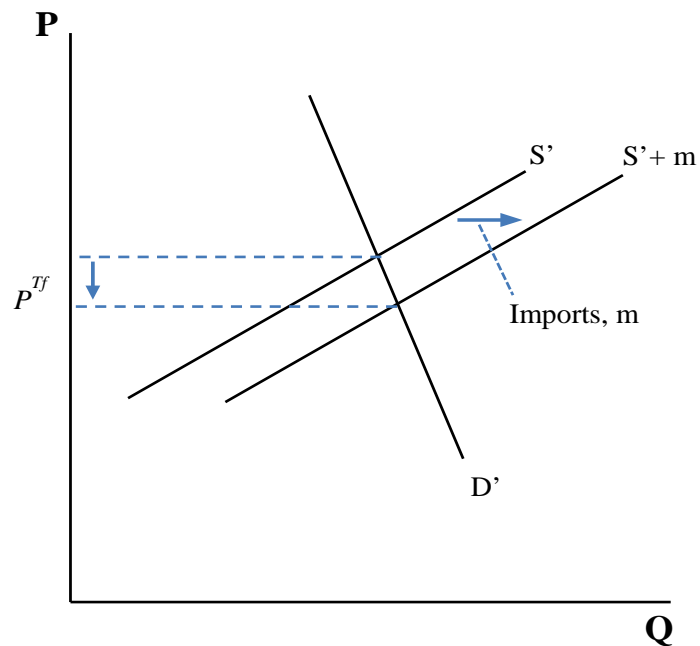
* - Results derived from the Rice World Gas Trade Model (RWGTM). The RWGTM was developed by Ken Medlock and Peter Hartley at Rice University using the MarketBuilder software provided by Deloitte MarketPoint .

Price Impacts of US LNG Exports: Introducing the Foreign Market Response

- When trade between two markets is introduced, price in each adjusts. The adjustments will depend on the relative elasticities of supply and demand.



Domestic Market



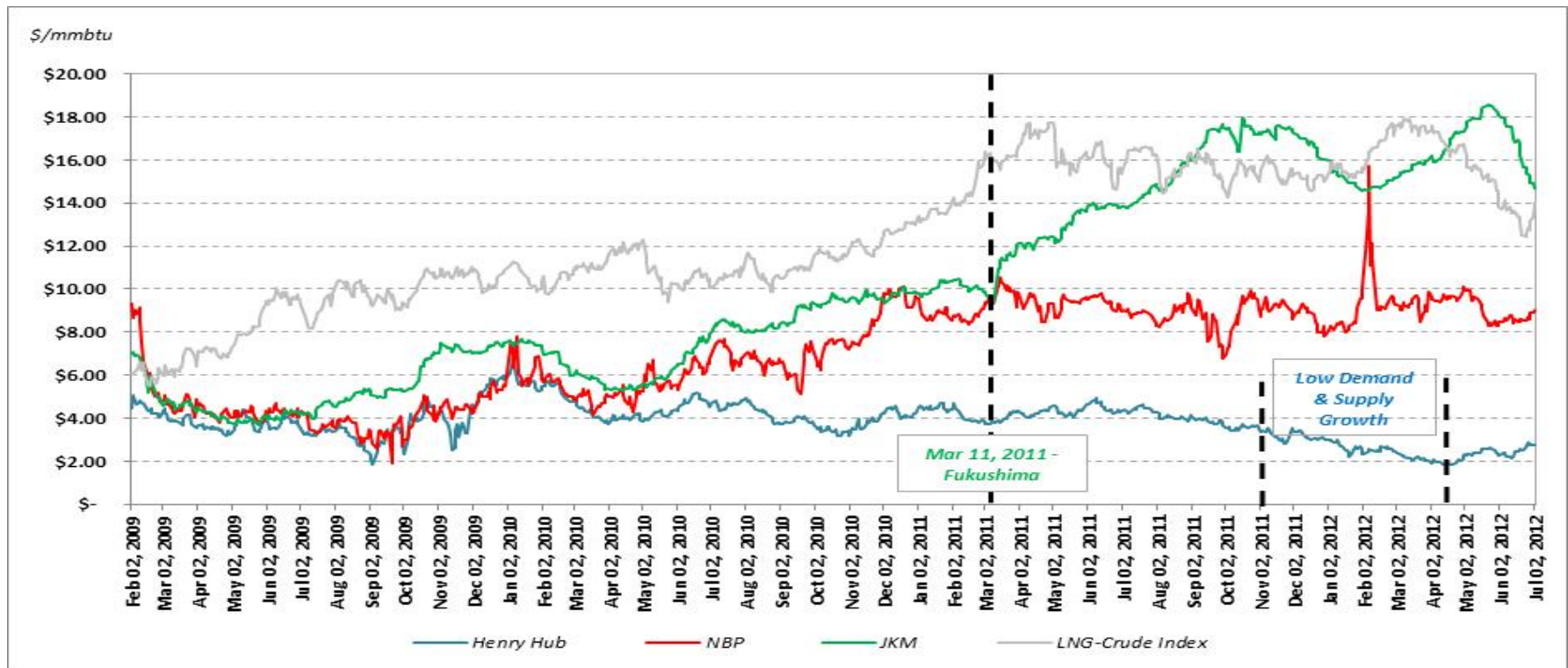
Foreign Market

The Impact of US LNG Exports

- Lots of attention given to current international spot price, but several factors are often ignored, such as
 - short term capacity constraints,
 - domestic market interactions with markets abroad, and
 - a weak US dollar.
- The pricing of “spot” natural gas in Asia changed significantly after Fukushima.
- US LNG exports could put significant downward pressure on international price.
 - In 2011, LNG trade totaled about 32 bcf/d. Current US filings total over 17 bcf/d.
- Repeat for emphasis... Effects of international trade are contingent on both domestic and foreign elasticities of supply and demand.

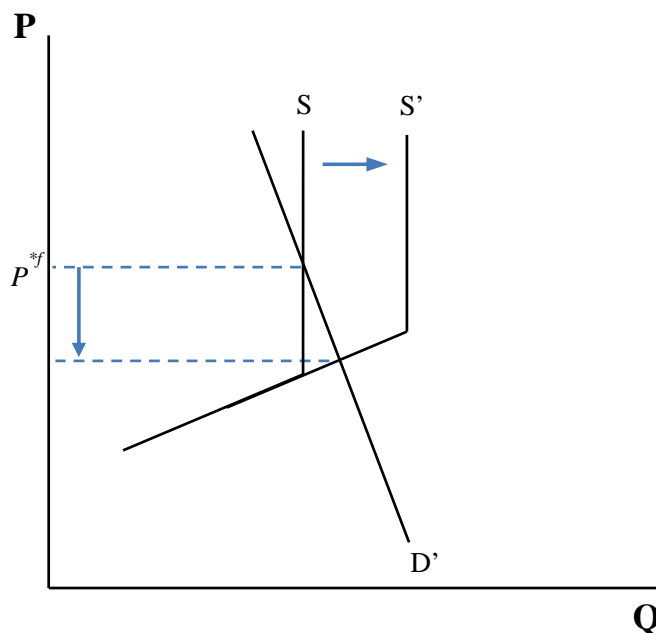
International Prices

- The relationship between spot markets has changed dramatically since March 2011. Will this change persist?
 - Unexpected demand factors have had an influence.
 - It is reasonable to expect that US price will rise to reflect marginal cost and JKM premium will subside with relief of deliverability constraint



Moving past the short term

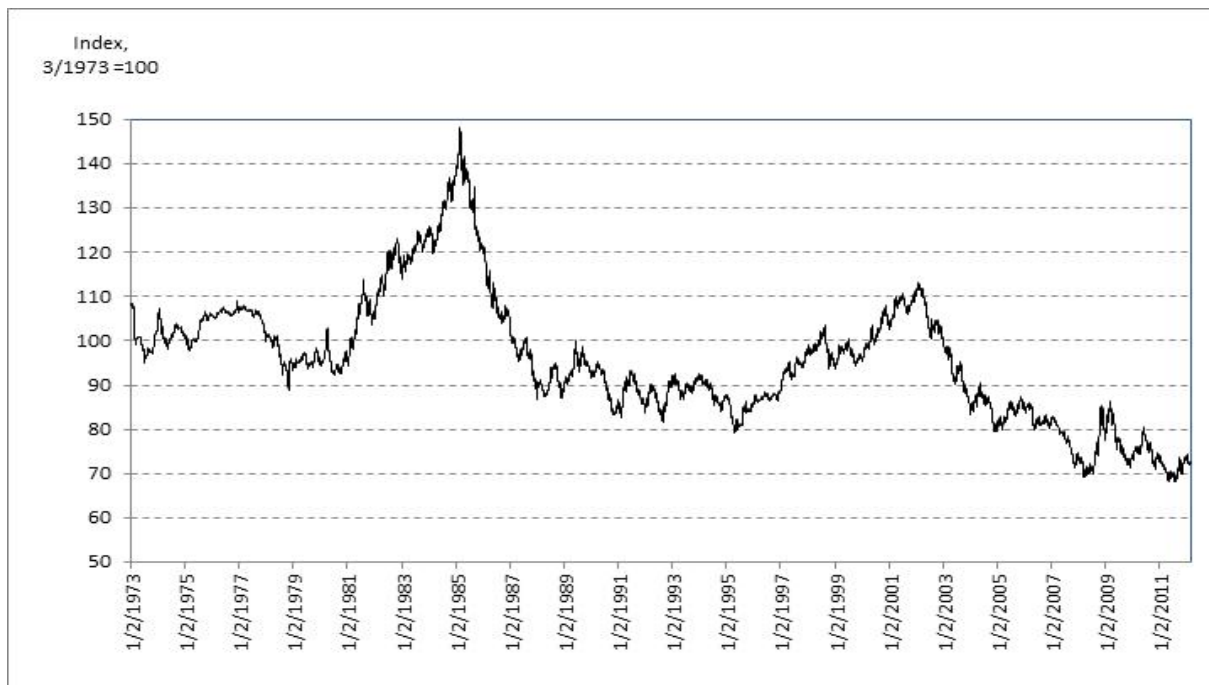
- Alleviating the deliverability constraint will have a large impact on international prices.
 - US exports could put downward pressure on international price.
 - Other supplies (for example, China shale, East Africa, Australia, Russia) will have competitive effects



Exchange Rate Effects

- Other factors that are important to the issue are the exchange rate, the role of liquidity in pricing paradigms, and foreign supply developments.
 - Exchange rate impacts: $P_{US} - P_{UK} \cdot XR \cdot HR = arb\ value$

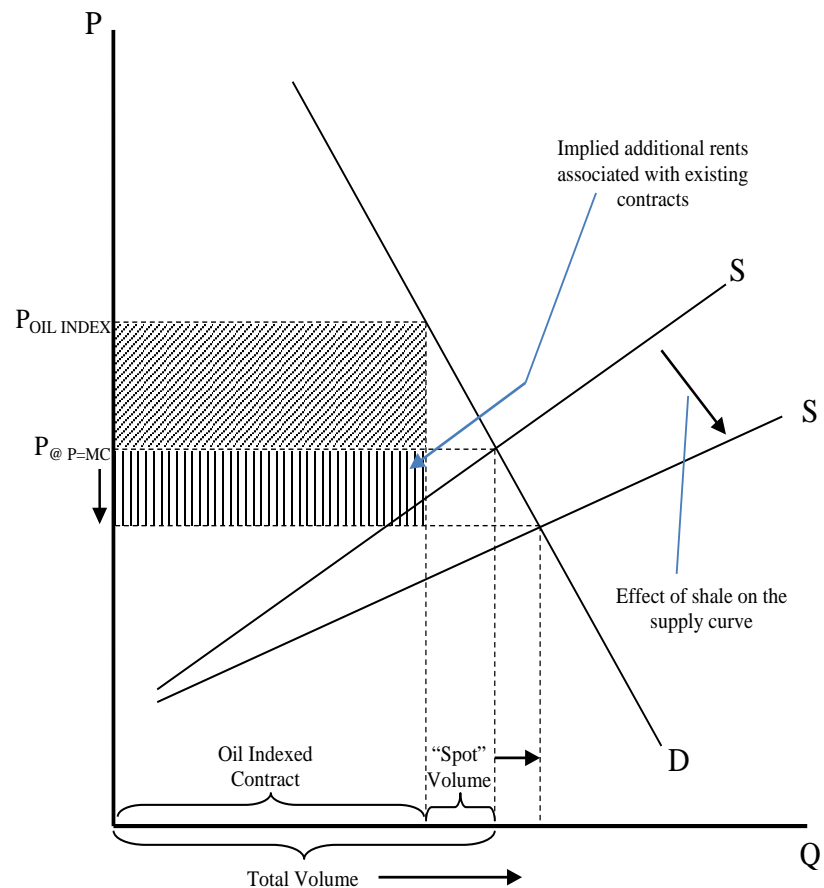
Trade-Weighted Value of US \$, Major Currencies (Daily, Jan. 1973–July 2012)



Contracts and Liquidity

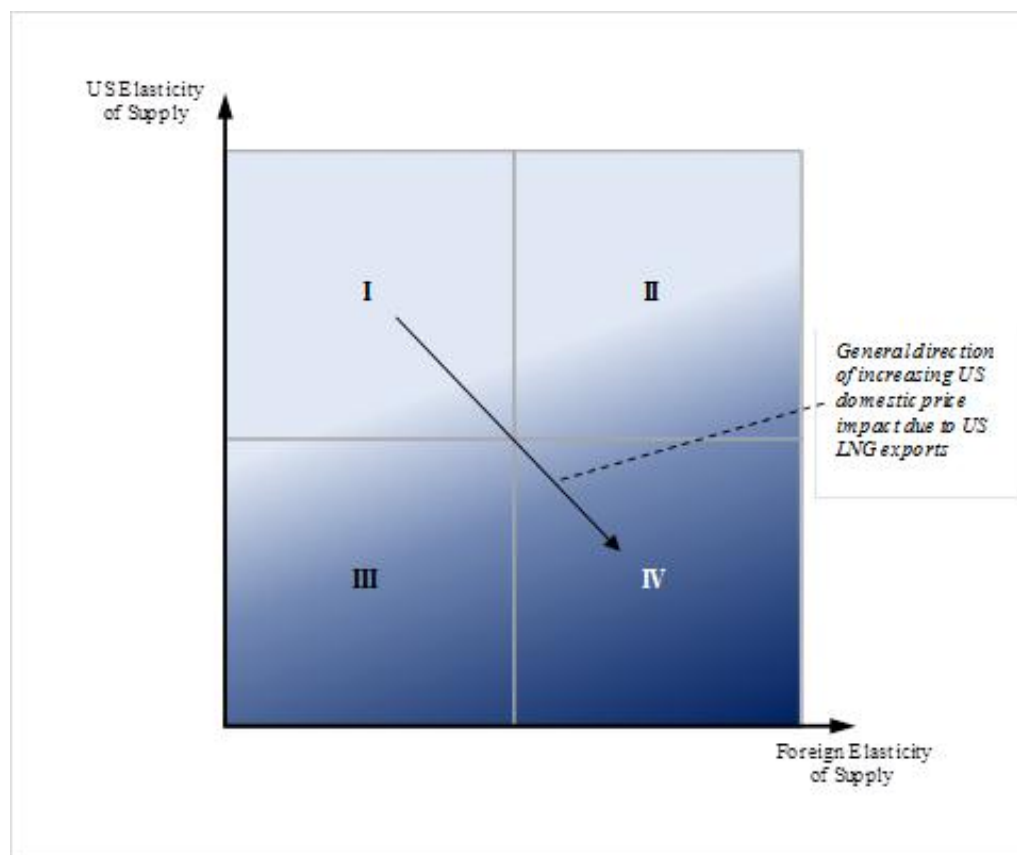
- Absent storage and physical liquidity, oil indexation provides an element of price certainty.
- Oil indexation is a form of price discrimination
 - (1) Firm must be able to distinguish consumers and prevent resale.
 - (2) Different consumers have different elasticity of demand.
- Increased ability to trade between suppliers and consumers (physical liquidity) violates condition (1).
 - This will happen in a liberalized market, or as LNG trade grows, or as hubs emerge in an end-use market.

The Supply Curve Effect of Shale and Implications for Price



The Marginal Profitability of Trade

- To understand what a license to export means for actual exports, we must examine the incidence on price of trade. Unfortunately, most analyses have focused on the US only. This ignores the interaction between the US domestic market and the market abroad.



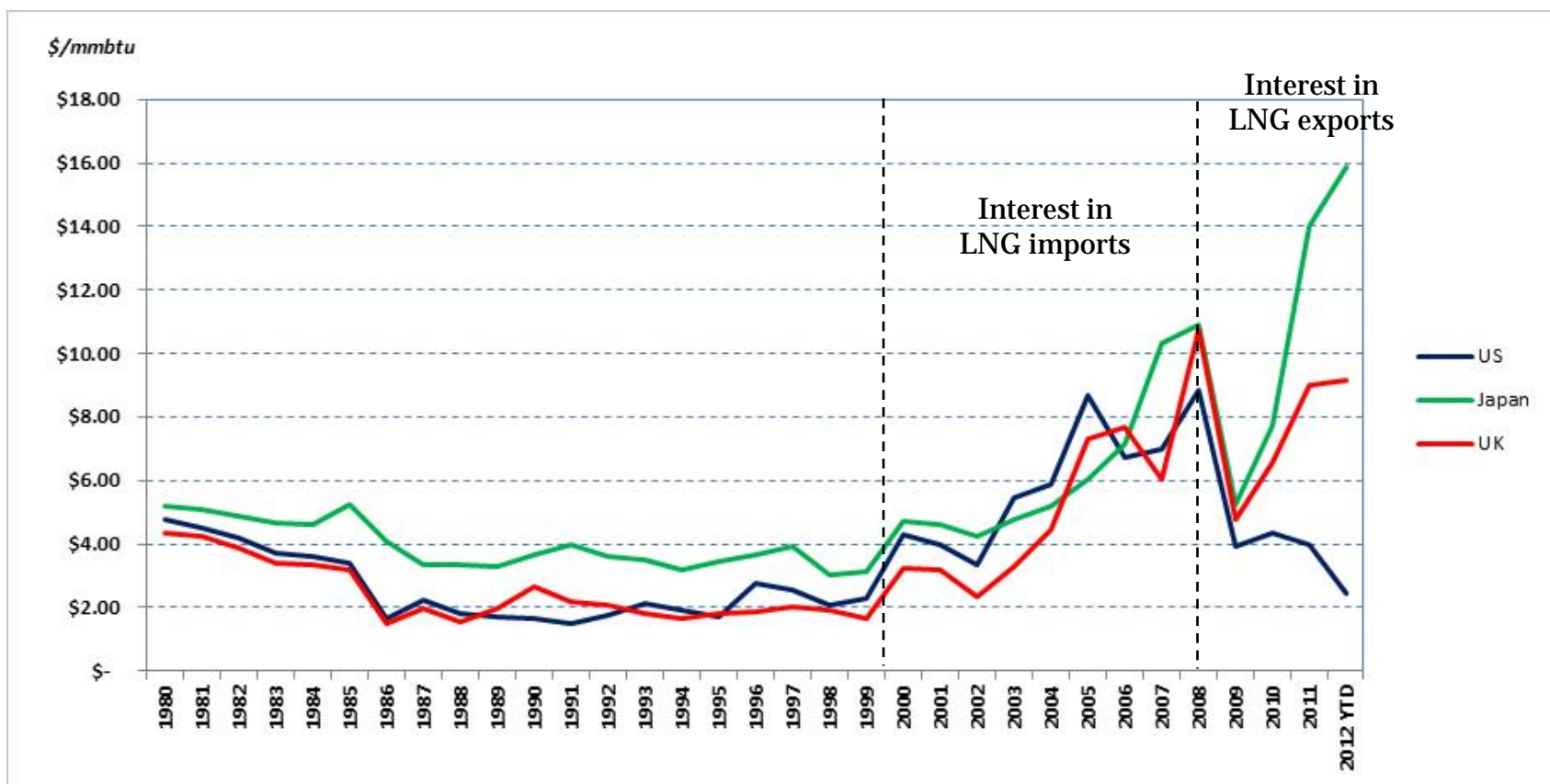
Results from the RWGTM: Case of US Gulf Coast LNG Arbitrage, 2011-2040

- Modeling indicates the current arbitrage value may be transitory. In fact, the positive export margin tends to disappear after 2015.
- Moreover, even substantial changes to the table values indicate the result is robust.

	<u>2011</u>	<u>2011-2020</u>	<u>2021-2030</u>	<u>2031-2040</u>
Feed gas cost (\$/mcf)	\$ 3.80	\$ 3.98	\$ 4.69	\$ 5.26
Liquefaction (\$/mcf)	\$ 2.92	\$ 2.92	\$ 2.92	\$ 2.92
Transport cost (\$/mcf)				
UK	\$ 1.07	\$ 1.07	\$ 1.07	\$ 1.07
Japan	\$ 2.15	\$ 2.15	\$ 2.15	\$ 2.15
Landed cost (\$/mcf)				
UK	\$ 7.79	\$ 7.97	\$ 8.67	\$ 9.25
Japan	\$ 8.87	\$ 9.05	\$ 9.75	\$ 10.33
Market price (\$/mcf)				
NBP	\$ 8.93	\$ 7.47	\$ 7.44	\$ 8.09
JKM	\$ 13.86	\$ 8.08	\$ 7.98	\$ 8.46
Export Margin (\$/mcf)				
UK	\$ 1.14	\$ (0.49)	\$ (1.23)	\$ (1.16)
Japan	\$ 4.99	\$ (0.96)	\$ (1.77)	\$ (1.87)

A Longer Term View of Prices

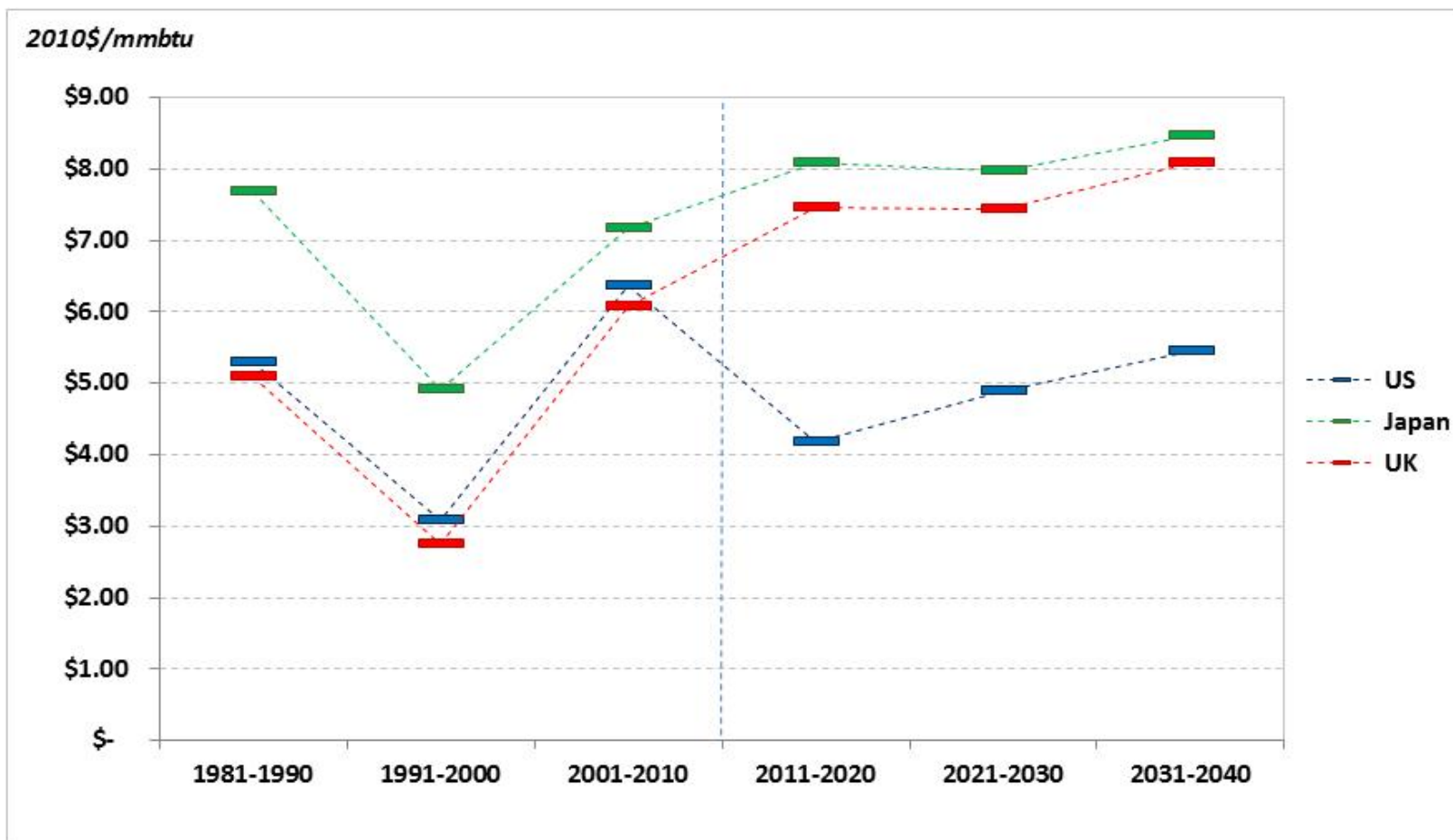
- The recent divergence is new... but can it persist? Or, is it a result of short term constraints?



Sources: Compiled from Platts, IEA, EIA

How do the RWGTM results compare to history?

- Henry Hub remains below the relationship that persisted historically, although the Asia price and NBP grow slightly closer.



Viability of US LNG Exports

- Current arbitrage value is high, but there is risk
 - Price impact in foreign market could be significant
 - Relative elasticities matter. Price impact abroad increases as domestic supply becomes more elastic and/or foreign supply becomes less elastic.
 - Risk of foreign supply developments
 - For example, Asia can be served by pipeline supplies from Russia, Central Asia, and South Asia; LNG from Middle East, Africa, Australia, Asia-Pacific, North America; and local supplies.
 - Exchange rate risk is present
 - Recent paper by Hartley and Medlock (2012) indicates exchange rates are important in determining the crude oil-natural gas price differential when (i) there is limited capability for direct arbitrage and (ii) fuel-switching capabilities are limited. Thus, oil-indexed flows are potentially exposed.
 - Gas-indexed trades are also exposed. Foreign gas is traded in own currencies, so exchange rates effect the arbitrage opportunity.
 - Increase in supply elasticity challenges traditional pricing paradigms
- Of course, uncertainties exist on all fronts!

Viability of US LNG Exports (cont.)

- Export capacity will be built on the expectation that current rents from arbitrage will persist long enough to “pay” for the upfront fixed cost. Once the fixed cost is sunk, the operating decision no longer hinges on the payment to capital. It is possible that some terminals will not operate at full capacity and will not earn the *ex-ante* required rate of return, contingent on the off-take agreement.
- US LNG export capacity could be used for seasonal arbitrage. While the annual load factor would be lower in this circumstance, if seasonal price differences among the regional markets are sufficient, US exports would be profitable.
- LNG exports from the US will link global markets to storage opportunities in the US. The US has the most well-developed storage market in the world, which contributes to market liquidity. By providing a link for the rest of the world to US storage capacity, the liquidity benefits could spill over.

Questions/Comments

The Oil-Gas Price Relationship

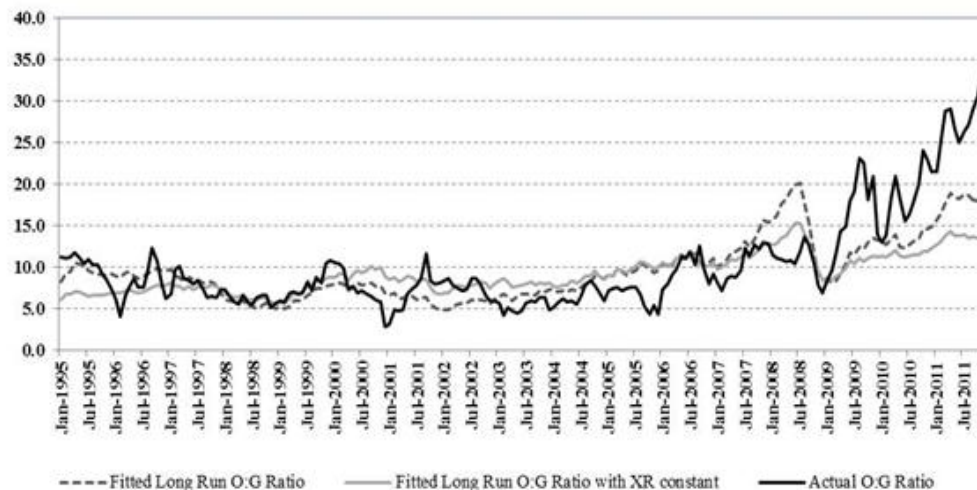
The Oil-Gas Price Relationship

- In the US, crude oil and natural gas prices have diverged from each other.
- Shale gas developments have contributed to this...
 - Increased available supply and contributed to storage overhang
 - Driven fuel substitution in power generation sector diminishing the margin of substitution with residual fuel oil
- Recent work by Hartley and Medlock (2012) indicate the price relationship is highly contingent on the value of the US dollar.
 - One commodity is fully fungible while the other is a non-traded good
 - Both commodities are potential substitutes for one another
 - Arbitrage between prices occurs de facto through fuel switching, unless the ability to switch is absent.
 - In this case, the exchange rate becomes the point of arbitrage between the commodities, meaning the exchange rate will be important in determining the price relationship.
 - Importantly, we also show that if fuel switching capability is present, the exchange rate effect is negligible.

The Oil-Gas Price Relationship (cont.)

- The long run relationship and the impact of the exchange rate, up to 40% of drift is explained by XR movements.
- Accounting for transitory factors explains the remainder of drift.
 - In the very recent history, warm winter and continued production growth combined to push storage well above normal ranges

Brent relative to Henry Hub



Brent relative to Henry Hub

